# Investigating the Pre-Service Teachers' Motivation and Learning Strategies and their Impact on Academic Performance: An Explanatory Study of Physical Sciences Specialization Pre-service Teachers at a Tertiary Institution in South Africa.

By

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# ABSTRACT

The purpose of this study was to provide the current status of the Self-regulated learning constructs; motivation and learning strategies of pre-service teachers majoring in Physical Science education specialisation and the impact these constructs have on academic performance. This purpose was met, through using a mixed methods approach within the pragmatic paradigm to answer three research questions. Two types of data collection instruments (surveys and interviews) were used sequentially to collect quantitative and qualitative data respectively. It was found that positive motivation profiles and frequent use of cognitive learning strategies had a positive impact on the academic performance of successful science students. Majority of the participating students were found to lack use of metacognitive learning strategies and resource management strategies, which is a great course for concern and possibly one of the main causes of the problems leading to superficial conceptual understanding and poor academic performance in South Africa. The findings of this study were not intended for generalising, hence they are specific to the context of pre-service teachers majoring in Physical Science education specialisation at tertiary institutions in South Africa and similar contexts. This study has potential to inform instruction towards assisting the Universities to produce Physical Sciences teachers who are motivated and who possess good teaching practices. It also has the potential to make a contribution to South African research on Self-regulated learning and academic achievement, which has been found to be minimal.

# DECLARATION

I, Nkosinothando Chamane, declare that:

(i) The research reported in this thesis, except where otherwise indicated is my original work;

(ii) This thesis has not been submitted for any degree or examination at any other university;

(iii) This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons;

(iv) This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

a) their words have been re-written but the general information attributed to them has been referenced;

b) where their exact words have been used, their writing has been placed inside quotation marks, and referenced.

(v) The work described in this thesis was carried out in the School of Education, University of KwaZulu-Natal, from January 2014 to November 2016 under the supervision of Lebala Miriam Kolobe (Supervisor)

(vi) The Ethical clearance No. HSS/0620/015M was granted prior to undertaking the fieldwork.

Signed:

As the candidate's Supervisor I, Lebala Miriam Kolobe, agree to the submission of this thesis.

Signed:

# ACKNOWLEDGEMENT

My sincere gratitude goes to the following people:

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My family, friends and colleagues for their understanding and encouragement

Our Heavenly father to whom all things belong to, for the wisdom, resilience and good health.

# DEDICATION

This thesis is dedicated to my family, that instilled in me the following perception; Education is the best investment to make and no one can ever take it away.

# ABBREVIATIONS

| | |
|---|---|
| Srl: | Self-regulated learning |
| IM: | Intrinsic motivation |
| SE: | Self-efficacy |
| DS: | Self-determination |
| CM: | Career motivation |
| GM: | Grade motivation |
| RH: | Rehearsal |
| EL: | Elaboration |
| ORG: | Organisation |
| CT: | Critical thinking |
| MC: | Metacognitive self-regulation |
| TSE: | Time and study environment |
| ER: | Effort regulation |
| PL: | Peer learning |
| HS: | Help seeking |
| SMQ: | Science motivation questionnaire |
| MSLQ: | Motivated strategies for learning questionnaire |

# DEFINITIONS

In this section, definitions of the terms used in this study and with reference to Pintrich et al. (1991); Duncan and Mckeachie (2005); Glynn et al. (2011) are given.

| | |
|---|---|
| Self-regulated learning: | A theory focusing on the learners' abilities to take control of their learning processes and environment to achieve academic goals. |
| Intrinsic motivation: | A type of motivation aroused from within, in this study it is looked at as referring to motivation to learn science for its own sake and because of interest. |
| Self-efficacy: | The student's belief that he/she can perform well in science. |
| Self-determination: | The control students believe they have over their learning. |
| Extrinsic motivation; | A type of motivation due to external factors. It involves learning the subject just as a means to an end. Examples include career and grade motivation. |
| Cognitive strategies: | Mental information processing strategies used by students. These may be simple or complex and examples include rehearsal and elaboration. |
| Metacognitive control strategies: | Refers to the use of strategies that help students control and regulate their cognition. Examples include planning, monitoring and evaluation. |
| Resource management Strategies: | Refers to the regulatory strategies students use to manage their resources; from time, study environment, lecturers mentors and other peers. |

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# CHAPTER 1
# INTRODUCTION

In this chapter, the research study about the motivation profiles and learning strategies of the pre-service teachers specialising in Physical Science at a tertiary institution in South Africa is introduced. The purpose of this study was to provide the current status of the Self-regulated learning (Srl) constructs motivation and learning strategies for pre-service teachers majoring in Physical Science education specialization and how these affect their academic performance. The topic areas covered in this chapter are the background and rationale of the study, the problem statement, objectives of the study, research questions, scope, research methodology, significance and organization of the study.

## 1.1 Background and Rationale of the Study

Academic achievement can be said to be the main measure of success in the South African education system, from both the political and the academic points of view. Academic performance in science subjects is however one of South Africa's education system's biggest challenge. The statistics reported by the Department of Education (DoE) over the past five years attest to this (47.6% in 2010 and 39.5% in 2014 of the grade 12 learners obtained less than 30% in Physical Sciences). It is important to note that it is not just the number of students that pass the subject that is of concern but also the quality of the results obtained by those learners that do obtain a matric pass (Equal education, 2015).

The problem to be highlighted from the given background information is poor performance in science subjects, where the main focus for the current study is Physical Sciences. Various factors contribute to this problem and the one in which this study focused on is discussed as part of the problem statement of this chapter. Many science education studies have been conducted to try and address such challenges, these include studies on assessment, the use of different textbooks, teaching and teacher education and so on… (Malcolm & Alant, 2004). This study aims to contribute to such initiatives through conducting a study guided by a theoretical framework adopted from a theory of learning referred to as Self-regulated learning (Srl).

The Srl theory is focused on the learners' ability to take responsibility and control of their learning processes. Schraw, Crippen and Hartley (2006) simply define Srl as a theory referring to learners' abilities to understand and control their learning environments to enhance their academic achievement. The relevance of this theory to the stated problem lies on the literature review findings associating it with coping mechanisms and learning processes that lead to good academic performance as briefly discussed below and further explained in detail in chapter 2.

In the recent years, there have been vast advancements in Science and technology, yielding many resources available for students to achieve academic goals. This has a potential to pose a lot of distractions and competing opportunities at the same time. According to Banarjee and Kumar (2014) students struggle to cope with the everyday conflicts that arise due to the existing distractions, at the same time they are expected to employ strategies and to develop the necessary skills to utilize their time purposefully to maximize their performance and achievement. Distractions may include rapidly evolving technology devices, social media and economy instabilities. Self-regulating their learning processes has the potential to help them cope with the rapidly changing scenarios of the present world. It is therefore very important to continuously explore student's practices and their abilities to regulate their learning processes to achieve academic goals. By doing this, the teachers and lecturers will be aware of the challenges students are experiencing and work towards addressing them as they teach, hence the interest in conducting this study.

## 1.2 Problem Statement

Lack of motivation and poor conceptual understanding has been identified as one of the contributing factors to poor performance in Physical Sciences (Yip, 2007; Muhammed, 2011). As a university student and as a student teacher I observed that many of my fellow students did not take learning for understanding seriously. They opted for learning strategies that lead to superficial understanding (like simple reading and memorizing) at the very last minute just to get the required 50% exam mark. The problem with this is that students complete degrees without understanding content, leading to further challenges outlined below. When student teachers complete their pre-service training without understanding, they will tend to teach the content at a superficial level, resulting in learners not understanding that content. When students do not understand a concept, they in turn lack the

motivation to study it, hence propagating the cycle of science teachers who are not motivated and do not have good conceptual understanding of the topics they teach (Tinajero, Lemos, Araujo, Ferraces & Paramo, 2012). Universities should be producing science teachers who are motivated to teach science, with self-regulated learning skills and good teaching practices.

## 1.3 Objectives of the study

The objectives of this study were: to determine the pre-service teachers' motivation to study Physical Science education; investigate what learning strategies they use when studying this subject and finally, to explore if there are any links between students' motivation profiles and academic performance as well as between learning strategies used by the students and their academic performance.

## 1.4 Research Questions

The purpose and objectives of this study discussed above were met through answering the following research questions:

1. What motivation profiles do pre- service science teachers have?
2. What learning strategies do pre-service teachers use to study Physical Sciences and why?
3. Are there any relationships between the Self-regulated learning constructs (motivation and learning strategies) and academic achievement?

## 1.5 Scope of the study

The Srl theory from which this study's theoretical framework is extracted from is very complex; it consists of further multi-component constructs. It is therefore very important for the scope of this study to be clearly outlined, demarcating the areas of interest from the very beginning. The scope of this study is to get first-hand knowledge about the South African university pre-service teachers and Srl constructs: motivation and learning strategies.

Five components of motivation were explored: intrinsic motivation, self-efficacy, self-determination, career motivation and grade motivation. Three learning strategy constructs were explored: cognitive strategies (rehearsal, elaboration and critical thinking), metacognitive strategies (organization and cognitive self-regulation) and resource management strategies (time and environment management, peer regulation and help seeking). These constructs make up the theoretical framework guiding this study.

## 1.6 Research Methodology

In this section, a brief summary of the research methodology adopted to achieve the objectives of the current study is discussed. The topics covered include the research approach, design, the participants and data collection techniques used in this study.

### 1.6.1 Research Approach and Design.

In Social science research studies similar to the current study, there are a set of fundamental assumptions and beliefs about how reality and knowledge attainment are perceived. These beliefs and assumptions serve as a framework which guides the research processes undertaken by the researcher to answer research questions, with the main models behind the research process being either quantitative and/or qualitative (Wahyuni, 2012). In the current study a mixed methods approach was used as briefly discussed below.

Research shows that quantitative research methods are very good at identifying and stating facts, yet poor at explaining the reasons behind those facts. On the other hand qualitative research methods are very good at providing deeper meanings and interpretation of what has been observed. I therefore regard combining quantitative and qualitative research methods as the best approach to answering research questions, as this allows for better understanding of social reality. Researchers with similar beliefs fall under the Pragmatism research paradigm (Mackenzie & Knipe 2006; Wahyuni, 2012).

The pragmatic paradigm places the research problem as central, applies more than one approach to understand the problem and works towards finding solutions (Mackenzie & Knipe, 2006).

According to Wahyuni (2012) instead of questioning ontology and epistemology, supporters of pragmatism start by looking at the research questions to determine their study's framework. Similar principles were applied in this study, which lead to the use of a mixed method approach, with quantitative and qualitative methods of data collection employed in a sequential design.

### 1.6.2 Participants and Sampling.

This study was conducted on students (majoring in Physical Sciences) from three undergraduate Bachelor of Education (B.Ed.) levels of study; levels 1 to 3. Each group of students (per level of study) was studied and analyzed independently to eventually make a contribution to the final in-depth report on the case of pre-service teachers as at tertiary institution in South Africa. There were two phases of participation in this study, that for quantitative data collection and that for qualitative data collection.

In the first phase, a survey was conducted to collect quantitative data, where all the students in each case were given an opportunity to participate voluntarily. Collected questionnaires were then sorted to eliminate invalid responses, resulting to a clean sample used for data analysis. In the second phase a purposeful sampling procedure was adopted to select interview participants, whose responses were used to elaborate on the survey findings. This is a common non-probability sampling technique with a principle based upon accessibility, and fitness for purpose (McMillan & Schumacher, 2010; Creswell, 2011).

### 1.6.3 Data Collection and Analysis.

Quantitative data was collected using a survey consisting of two questionnaires, sequentially followed by qualitative data collection using one-on-one interviews. The survey was conducted first, to get an idea of the overall situation and the interviews were then conducted thereafter to elaborate on the survey findings.

The quantitative data in the form of numbers was coded and captured onto an excel spreadsheet and categorized according to themes. Descriptive statistical analysis was employed to analyze data in response to research questions 1 and 2. The students were then categorized into three groups

according to their academic performance to further explore relationships between academic performance and each of the two Srl constructs of interest to address the third research question (the justification of the selection of what should constitute judgment on achievement categories is given in section 3.7). The findings were presented using graphs, tables and elaborative comments in relevant chapters.

The qualitative data in the form of interview responses were transcribed and captured in a summary table following Cohen, Manion and Morrison (2007); Leedy and Ormrod (2010) guidelines. These interview responses were used to elaborate on the survey findings. Full detail on the methods, approaches and research instruments employed to answer this study's research questions is given in chapter 3. This is followed by a discussion on how ethical issues as well as validity and the reliability issues were addressed.

## 1.7 Significance of the study

This study has the potential to inform instruction and to stimulate the minds of the pre-service teachers into assessing their motives and actions as they study science, that they may pay attention to the impacts these constructs have on their academic performance and that of the learners they will teach in the future. This will in turn assist in solving part of the learning for understanding problems as well as the academic performance problems in science faced by this country.

The findings of this study will inform instruction and contribute to the knowledge about learning in the higher education system in South Africa and similar contexts, which can help enhance conceptual understanding and academic performance. Through this our South African universities can be assisted in their mission to produce good science teachers who are motivated and with good teaching practices.

## 1.8 Organization of the Study

In Chapter 1, the study is introduced, giving the background, rational, focus, scope, research processes employed and the overview of the full study conducted.

In Chapter 2, a review of literature on the areas of interest is provided, providing global and local perspectives on the current knowledge status on Srl and Academic achievement, Motivation and Learning strategies. The theoretical framework, positioning of this study and the aimed value contribution to South African research of this nature are also discussed, concluding with a rationale for the combination of motivation and learning strategy constructs.

In chapter 3, a description of how this study was designed, approached and carried out is provided. The paradigm guiding this study and the methods of data collection are explained, elaborating on how these were considered suitable for use to answer research questions. The processes followed to address ethical issues, issues of validity, reliability, trustworthiness and credibility are also discussed in this chapter.

In chapter 4, quantitative and qualitative data are presented and analysed in line with the current study's theoretical framework.

In Chapter 5, the findings made in light of the current research literature are discussed to answer the study's research questions.

In Chapter 6, a summary of findings and conclusions made, limitations and recommendations for future research are provided.

# CHAPTER 2
# REVIEW OF LITERATURE

The aim of this chapter is to give a basic literature review specific to the areas of interest mentioned in chapter one. According to Machi and McEvoy (2012, p.1) "A basic literature review is a written document that develops a case to establish a thesis. This review synthesizes current knowledge pertaining to the research question". The purpose of this review is to summarize and evaluate the existing knowledge on Self-regulated learning (Srl) constructs, to argue a position about the current state of knowledge. As to be shown in the paragraphs to follow, Srl is a broad and complex theory, hence it is important for researchers in this field to clearly demarcate the areas of interest and the context in which these are explored. The Srl constructs of interest are "Motivation" and "Learning strategies" of pre-service teachers majoring in Physical Sciences specialisation. These constructs are made up of further components (also referred to as scales for data analysis purposes) which all combine to form the theoretical framework of this study.

This chapter is begun by giving a background of the Srl theory, definitions and observed relationships with academic achievement as reported by many researchers over the years. The first section is concluded by a local background and a discussion of the positioning of the study. The theory is further discussed in its whole complexity and then narrowed down to focus on the selected constructs constituting the theoretical framework guiding the study. Empirical studies on both motivation and learning strategies are then discussed in their respective sections followed by a discussion of some of the research studies conducted using similar research methods as those employed in this study. The chapter is then concluded by the rationale (supported by literature) for the source of interest to conducting this type of study and the value to be added to the South African literature on the selected constructs of Srl in general.

## 2.1 Srl Theoretical Background

The topic of how students become self-regulators of their learning has been of interest to researchers internationally for decades, Zimmerman (2008) in a study to investigate self-regulation and motivation attests to this. According to Butler and Winne (1995) and Zimmerman (2008), over the past

two decades, researchers have applied the Bandura (1977) social- cognitive theory to various settings, including teaching and learning. This theory was designed to “explain how people acquire competencies, attitudes, values, styles of behaviour and how they motivate and regulate their level of functioning” (Bandura, 2006, p. 54). Its applications led to the development of various theories including social constructivism and the self-regulated learning theory. The Srl theory contends that learning is governed by a variety of interacting components including cognition, metacognition, motivation, behaviour and environmental conditions.

Many definitions of Srl can be found from different authors: According to Schraw, Crippen and Hartley (2006), Srl involves combining cognitive strategy use, metacognitive control, and motivational beliefs to achieve academic success. Whereas Zimmerman (2002) describes Srl as referring to self-generated thoughts, feelings and behaviours that are oriented to attaining goals. Shraw and Brooks (1999) identify the Srl aspects that play an important role to the extent to which students self- regulate their learning to be self-efficacy and the use of relevant learning strategies. The common idea amongst these descriptions is the combination of motivational aspects with the actions taken by individuals towards attaining academic goals.

Majority of recent studies on Srl globally are now linking this theory and its constructs directly to academic achievement. The findings of such studies will inform the current study in its purpose to use the Srl theory to investigate the impact of two of its main constructs on achievement. According to Schunk, 1981(as cited in Zimmerman & Schunk, 2011) Srl is an effective means to improving performance of students with different ranges of proficiency. Effeney, Carroll and Bahr (2013, p.58) sum up an effective self-regulated learner to be "one who actively sets goals, decide on appropriate strategies, plans their time, organize and prioritize materials and information, monitor their learning by seeking feedback on their performance and make appropriate adjustments for future learning". These aspects of Srl were explored in this study and other empirical studies conducted in this area are discussed further in the sections to follow.

## Srl in the South African context.

Studies on Srl and achievement for tertiary students conducted in South Africa are limited. Most of the available studies looked at individual constructs of Srl like attitudes, motivation and learning

strategies. In this section a review of local studies on Srl and those on Srl constructs of interest (motivation and learning strategies) is discussed to give a background of the available knowledge in this study, concluded by discussing the positioning of this study.

Studies conducted locally on Srl and achievement include Mcmillan (2010) “Your thrust is to understand how academically successful students learn” and Bothma and Monteith (2004) "Self-regulated learning as a pre-requisite for successful distance learning". These scholars found that academically successful students are self-regulated learners, furthermore, Bothma and Monteith (2004) emphasized that successful distance learners applied more and/or different Srl strategies than non-successful learners. In their studies, the above-mentioned researchers focused on exploring the general relationships existing between the application of Srl strategies and academic achievement. They did not explicitly focus on selected constructs of Srl, as done in the current study. For example, some of the aspects of motivation like the love of the subject and the actual Srl strategies of learning adopted by the participants were not discussed in detail. Mcmillan (2010) only used qualitative methods of data analysis in a cohort of ten students producing a rich case that can only be limited to giving a description of that particular group of students. Based on the findings of the two studies, a positive relationship exists between Srl and academic achievement of students in a South African context.

Local studies on selected constructs of Srl include Lebuso (2010) and Watson, Mcsorley, Foxcroft and Watson (2004). Lebuso (2010) investigated the learning strategies employed by successful high school learners. He argued that Srl strategies like cognitive strategies and resource management strategies played a huge role in the academic success of the learners that participated in his study. Watson et al. (2004) explored the motivation and learning strategies of first year university students at the University of Port Elizabeth, and found the explored constructs to be the best predictors of learners that succeed academically. These studies form part of the empirical studies supporting the aims of the current study. Their findings together with those of the other local studies mentioned above were used to give a background on the current status of the available knowledge on Srl in South Africa (which is minimal) and also to inform data collection and analysis. More detail is given in chapter 3.

The current study is in agreement with the arguments made through the local studies discussed above. One of the aims for conducting this study was to add to this type of knowledge by taking the

local researchers' findings a step further, through exploring selected pre-service teachers' motivation, their learning strategies and the impact these have on their academic achievement.

Looking at the reference lists of the local studies made reference to above, as well as other local research studies on learning (Malcom & Alant, 2004; Frick, Carl, & Beets 2010) only about 30 percent of the list is made up of South African papers. This in addition to other local studies (including Mcmillan, 2010; Lebuso, 2010) touching on the limited research studies on Srl in this country is evidence of minimal research in this area.

## 2.2 Theoretical Framework

A theoretical framework stemming from the Srl theory mentioned above guides this study. The Srl theory is complex and consists of many constructs, two of them namely; Motivation and Learning strategies have been selected to constitute the theoretical framework of this study. In the paragraphs to follow, literature providing definitions of Srl will be discussed and then narrowed down to focus on the selected constructs, providing reasons for this particular selection.

From the definitions of Srl outlined in the background section above, it is evident that Srl is a complex theory with constructs supporting the idea of students becoming masters of their own learning. Collectively these definitions highlight the main constructs of Srl to be Motivation, attitudes, feelings and behaviour oriented towards achieving set goals, self-efficacy, cognition, metacognition, learning strategies and the ability to control these constructs to achieve educational goals. For the purposes of this study, Motivation and Learning strategies were explored as the main constructs of interest. These constructs were specifically selected because most of the other Srl constructs mentioned can be said to be sub-constructs or components of motivation and learning strategies and many of the studies reviewed show that motivation and learning strategies are the main predictors of good academic achievement. Further detail on this subject is given under the discussion of each of the constructs of interest.

### 2.2.1 Motivation.

Motivation is a very important aspect of Srl and has been studied by many researchers on its own and in conjunction with other educational aspects like performance, attitudes and behavior. Scholars writing about motivation and performance emphasize the role of motivation in promoting and sustaining self-regulated learning (Pintrich, 2003; Schraw, Crippen & Hartley, 2006). In this section, selected definitions of motivation and its constructs will be outlined, highlighting the common ideas in relation to self-regulated learning and academic achievement.

Koballa and Glynn (2006, p.85) define Motivation as "an internal state that arouses, directs and sustains student behaviour". In their review of literature on motivation studies, these researchers found that many motivational constructs have been created and they are often unclear in their definitions and constructs. They went on to name the most relevant constructs of motivation to science education researchers as those of intrinsic motivation, which include personal interest, arousal, anxiety, self-efficacy, self-determination and self-regulation. There is also an aspect of extrinsic motivation, which they explained as motivation to perform as a means to an end or a means to attain physical rewards (Pintrich & Schunk, 1990 as cited in Glynn & Koballa, 2006). Other researchers with similar views include Areepattamannil, Freeman and Klinger (2010); Glynn, Brickman, Armstrong and Taasoobshirazi (2011). According to these researchers, motivation is a multicomponent construct and can be categorized into intrinsic and extrinsic motivation. In the paragraphs to follow, these components of motivation are discussed in detail as forming part of this study's theoretical framework.

#### Intrinsic motivation.

Intrinsic motivation can be simply defined as referring to individual behaviours performed out of personal interest and enjoyment. It is normally associated with self-efficacy, self-confidence, self-determination, self-perception and inherent satisfaction in learning the subject for its own sake (Arrepattamannill et al., 2010: Glyn and Koballa, 2006). Self-efficacy is defined as a term referring to personal beliefs or to an individual's confidence in his own ability to perform specified tasks effectively (Muhammed, 2010). Self-determination on the other hand refers to the control the individual believes they have over their learning of the subject (Glynn et al, 2011). In discussing these constructs, Bandura (2001, p.10) argued that "Efficacy beliefs play a central role in the self-regulation of motivation through goal challenges and outcome expectations. It is partly on the basis of efficacy beliefs that people choose what challenges to undertake, how much effort to extend in the endeavour, how long to

persevere in the face of obstacles and failures, and whether failures are motivating or demoralizing". Intrinsic motivation, self-efficacy and self-determination are about the individual's interest on the subject, followed by the confidence they have on their capabilities and efforts. If these are regulated appropriately good academic performance can be expected.

In this study, three motivation scales namely; intrinsic motivation, self-efficacy and self-determination were studied in combination as they are all motivation components concerned with the individual's state aroused from the inside. These components are said to be mutually supporting components of motivation and were found to play an important role in students' performance (Glynn et al, 2011).

### Extrinsic motivation.

Available research studies on this aspect of motivation were found to be minimal. In most of the literature reviewed, extrinsic motivation was found discussed concurrently with intrinsic motivation, with focus often being on the la tter. This construct of motivation is associated with change in behaviour due to external influences and can be defined as referring to behaviours carried out to attain contingent or conditional outcomes or as motivation to perform as a means to an end or a means to attain physical rewards (Arrepattamannil et al., 2010; Glynn & Koballa, 2006).

Aspects of extrinsic motivation specific to science learning selected to form part of this study's theoretical framework are grade motivation and career motivation. According to Glynn, et al. (2011) these scales target more precisely the primary 'ends' that tertiary students focus on. Those are; grades as important short term goals that measure academic success and careers as important long term goals that measure success in the society. These two scales of extrinsic motivation were selected because they fit the purpose and scope of this study. As a researcher, science student and employee myself, I have also observed good grades and career goals to be the main motivation factor for many in the science community and are an interesting area to explore. Furthermore, this study takes cognisance of other possible forms of extrinsic motivation including motivation due to rewards like gadgets attained from home, however it would not be feasible to cover all these aspects of this motivation scale within the scope of this study.

### 2.2.2 Learning Strategies.

In this section, different definitions given to the term learning strategies and respective examples are discussed, highlighting common ideas. A discussion and justification of the learning strategies of interest selected for this study follows, concluding with the components making up this study's theoretical framework.

The term learning strategies can be defined as a collective term given to activities that students engage in to enhance knowledge attainment and improve learning (Dargle, Rachal & Rachal, 2007). Dole, Duff, Roehler and Pearson (1991) define learning strategies the same way, but they use the term "tactics" instead of "activities". These tactics may include; note-taking, forming questions, visualizing, discussing with others, summarizing, asking for help and many more. Several authors including (Alexandra and Murphy, 2006; Bembenutty, 2009) base their definitions of learning strategies on mental activities only, with no association with behaviour. Cantor (as cited in Lebuso, 2010) gives a more elaborative definition of learning strategies as cognitive, affective and behavioural activities that students use to achieve and evaluate their academic goals. Pintrich, Smith, Garcia & Mckeachie (1991) give a guide to investigating an even wider range of learning strategies, which also assisted in processes followed to conduct the current study. Detail on their guide and the use of their data collection instrument is given in chapter 3.

Various definitions of learning strategies exist depending on the different author's perspectives as discussed above. The most important factors of interest include mental activities and actions taken to use these to achieve academic goals. The interest on learning strategies as a significant construct of Srl lies on three learning strategy components namely, cognition, metacognition and resource management strategies. A discussion of these components together with a justification for their selection follows, highlighting the role they play in the students' processes to enhance academic performance.

#### Cognitive strategies.

Cognition can be simply defined as a term referring to the mental processes involved in gaining knowledge and understanding. These may include reasoning, judgment, elaboration, critical thinking

and activity monitoring. From reviewing multiple definitions Tinajero et al. (2012) defines cognitive styles as consistent patterns in perceptual and intellectual activity, these have an impact on behaviour specifically when it comes to interpretation of situations and decision-making. According to Mayer and Alexandra (2011) new views in philosophy of science and science studies have adopted cognitive and social frameworks to understand the growth of knowledge. This emphasizes the importance of looking at the cognitive strategies that the students employ in their learning of science.

Cognitive learning strategies can be categorised into two main categories according to the depth of information processing attained by using a certain strategy (Lebuso, 2010; Tinajero, 2012). The first category consists of surface processing strategies and the second one consists of deep processing strategies. Support to this classification is explained by strategies such as simple reading and memorising, which fall under the first category as they offer superficial understanding. On the other hand, organising, critical thinking and elaborating will fall under the second category because according to Soric and Palekcic (2009) these strategies allow students to organise learning material and to create relationships and trends between prior knowledge and new knowledge, which leads to enhanced understanding. On the same subject, according to Tinajero et al. (2012, p.106) "Using selection strategies, students separate relevant from secondary, redundant or confusing information, to facilitate a deeper processing of the former; related actions comprise note-taking and summarizing".

Based on the literature discussed above it can be argued that proper and systematic employment of cognitive strategies enhances learning for understanding and hence academic performance. The use of these learning strategies mainly focusing on the components: rehearsal, elaboration and critical thinking were explored in the current study using questionnaires, and the motive behind their use was elaborated upon using one-one interviews.

### Metacognition.

Metacognition is a theory originating from developmental psychology with Flavell (1970); Piaget and Inhelder (1958) as originators, where it initially focused on the reflective abstraction of new or existing cognitive structures. Mayer and Alexandra (2011) simply define metacognition as referring to the person's thinking about cognition and its regulation. These researchers ascertain that students, who use metacognitive strategies, regulate, monitor and evaluate their learning activities towards good

academic achievement. Pintrich et.al. (1990) is of the same view, he referred to metacognition as being made up of three general processes; planning, monitoring and regulation. These are assumed to improve performance by helping the learner check and correct their learning tactics as they proceed with their tasks.

Metacognition researchers consider self-regulation to be a subordinate component of cognition, whereas Srl researchers regard Self-regulation as a concept superior to metacognition, i.e. cognitive regulation next to motivational and affective regulation (Veenman, van Hout-Wolters & Afflerbach, 2006, as cited in Zimmerman & Schunk 2011). Based on the review of multiple research studies it is justifiable to agree with the views of the Srl researchers' about perceiving cognitive learning strategies and metacognition as crucial components of self-regulation, hence in the current study cognitive and metacognitive strategies were explored as part of the learning strategies used by self-regulated learners.

The components of metacognition explored in this study are (1) organisation, which looks at the students' ability to plan and organise their work and learning activities accordingly and (2) metacognitive self-regulation, which focuses more on the student's thinking and reflection on the way they study science. (Pintrich et al., 1991; Duncan & McKeachie, 2005)

### Resource management strategies.

When young students arrive at the university, they encounter many changes as they get into a new community full of a wide range of resources including other peers, computers, libraries and laboratories. Proper utilisation of these and other resources is crucial for academic success. According to Zimmerman (2008) self-regulated students take an active role in their learning to achieve academic goals. This means that these types of students take it upon themselves to manage their time and resources well to enhance learning and achievement. Pintrich et al. (1991) argue that "besides self-regulation of cognition, students must be able to manage and regulate their study environments". During my search for research studied on learning strategies, Literature explicitly focusing on exploring the use of resource management strategies was not found. However, the general argument is that students who actively manage their resources will perform better than those that do not. This argument

is supported by research evidence from local researchers including Botma and Monteith (2004); Lebuso (2010); Mcmillan (2010) as discussed further in section focusing on empirical studies below.

In the current study four components of resource management strategies namely, time and study environment management, effort regulation, peer regulation, peer learning and help seeking were explored. These were specifically selected because they are the main resource management strategies directly associated with Srl and can be classified as resources observed to be common to most students. The regulation of other resources is also regarded as significant to academic achievement, however, specific investigation of the regulation of other resources like the use of internet and other media will require employment of more research instruments not covered within the scope of this study.

To conclude this section, a summary of the constructs and their branch components constituting the theoretical framework guiding the current study are as follows: (1) motivation with two constructs: Intrinsic motivation associated with self-efficacy and Self- determination components and then extrinsic motivation made up of career and grade motivation components. (2) Learning strategies comprising of three multi-component constructs of interest: Cognition, metacognition and resource management strategies. These are best illustrated in Figure 2 below:

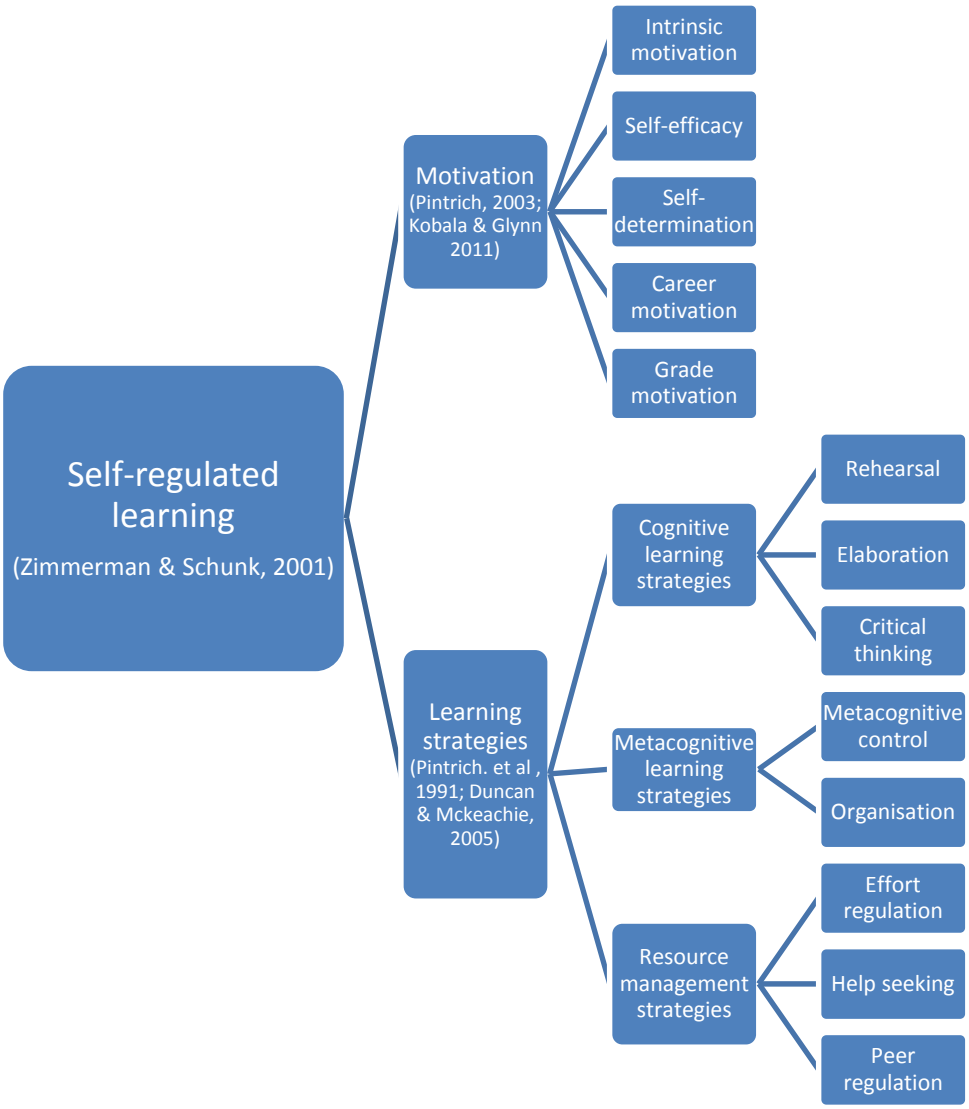


Figure 2.1. Illustration of the Srl constructs constituting the current study's Theoretical Framework, as adopted from Zimmerman and Schunk (2001) Srl theory.

## 2.3 Empirical studies

In this section a review of available empirical studies on Srl and academic achievement, motivation and its components, learning strategies and its components is given. The purpose of this review is to summarize and evaluate the empirical studies conducted on the above-mentioned constructs, to argue a position about the current state of knowledge and to provide supporting evidence for the research claims made in this study's theoretical framework.

### 2.3.1 Srl and academic achievement.

Lindner and Harris (1992) found that Srl is an important element in college student performance and the ability to self-regulate learning processes grows with age and academic experience. This is an old study, but it has been cited by many significant researchers of Srl including Zimmerman and Schunk (2001). Similar views are shared by the current study. Effeney et al. (2013) also found that the early habit forming experiences of learning are an important foundation for Srl during later years. On the same subject, in a recent PhD study conducted in Korea it was found that the successful college students believed that their successful academic performance at the university was due to their self-regulatory systems and effective time management (Kim, 2015).

Effeney et al. (2013) in their study to identify the key self-regulated learning strategies and their sources for adolescents, found that the more academically capable students were more self-resilient than the less academically capable. They went on to say that "This may be a reflection of higher levels of self-regulatory skills, and higher levels of other factors that support Srl, such as self-efficacy and motivation" (Effeney et al., 2013, p.64). McMillan (2010); Bothma and Monteith (2004) also share similar views. In their local studies they found that academically successful students are self-regulated learners, with the most significant constructs of Srl explored being learning strategies and motivation.

A strong argument on the positive impact that Srl and its constructs have on academic achievement is evident, supported by the findings of older and newer research in this field from both local and international perspectives. No research was found in contrary to this argument.

### 2.3.2 Motivation.

Reviewed empirical studies on intrinsic motivation, its associated constructs and academic achievement are discussed in this section. There were no empirical studies explicitly focusing on extrinsic motivation components found, but only brief discussions of this construct as part of the studies on intrinsic motivation. A discussion of studies exploring behaviour associated with motivation and the impact these have on academic achievement concludes this section.

#### Intrinsic motivation, associated constructs and academic achievement.

Middleton and Spanais (2002) argue that intrinsic motivation is better than engagement for a reward. The current study is based on the same view since the effect of motivation from within will last longer than that of a gadget that will lose value over time. Areepattamannil and Freeman (2011) in their research study examined the relationships between intrinsic motivation, extrinsic motivation and academic achievement for the Indian immigrants in Canada. They found that intrinsic motivation has a positive effect on academic achievement as they had predicted prior to conducting their study. Bryan, Glynn and Kittleson (2011) in their study of motivation and achievement found that the student's intrinsic motivation, self-efficacy, self-determination and performance are related and self-efficacy is the component most related to achievement. Muhammed (2011) also attests to this.

According to Areepattamannil, et.al (2010) motivational beliefs, self-beliefs and self-concept have a significant effect on science achievement. These writers in their study found that the adolescents with high levels of confidence in performing science related tasks and with a more positive perception of their ability to learn science, tended to perform better than those with less self-efficacy. Surprising findings from the same study were that interest in science had a negative effect on science achievement of the same adolescents. This is contrary to what was reported above concerning intrinsic motivation and its positive impact on achievement. There was no literature in this area to support this view, hence these findings were taken into account at data analysis in exploring other possibilities on this matter.

### Motivation and Behaviour.

Motivation can be associated with goal setting leading to changes in behaviour and academic achievement. Effeney et al. (2013) found that the academically higher ranked students regularly adapted and “fine-tuned” their academic habits in an incremental manner, he went on to say that this process of on-going incremental change to Srl techniques may be the result of high levels of motivation and consistent self-reflection. Bryan et al. (2011) also argue that students who are motivated to learn science and engage in science-learning behaviour pursue goals such as good achievement in science and science related careers. Furthermore, these authors emphasize that it is important to examine what contributes to student's motivation in order to explain it best. The same views are shared in the current study as it is one of the aims in this study to determine the motivation profiles of the Physical Sciences pre-service teachers.

To conclude the arguments stemming from the reviewed studies; motivation is best described as a person's internal state that influences behaviour. It has intrinsic and extrinsic motivational aspects, where intrinsic motivation and associated constructs (Self-efficacy, self-perception and self-determination) are advocated to be the best promoters of self-regulated learning principles leading to achievement of set academic goals. Finally, motivation can be associated with goal setting leading to changes in behaviour and academic achievement.

### 2.3.3 Learning Strategies.

In the following section, reviewed empirical studies on learning strategies locally and globally are discussed to support the three learning strategy components constituting this study’s theoretical framework and their impact on academic achievement of university students.

According to Effeney et al. (2013, p. 68). “The more academically capable participants reported using a wider range of strategies, and more often than the less academically capable participants”. In a local study to explore learning strategies used by successful high school science learners, Lebuso (2010) had similar findings. He found that the academically successful learners engaged more in self-regulatory activities, and they were influenced in their studies by factors such as family support, the love of the subject and their goals and ambitions. The literature reviewed and the findings of his study

informed the current study, since similar research aims, concepts, and methods of data collection were employed in a similar context of Physical Sciencess learning in South Africa. One of the aspects that was elaborated on in the current study, not explored in detail in Lebuso's study is that of resource management strategies. This may come about due to the different types of participants in the two studies. University students are expected to employ more of these strategies than high school students, mainly because of the differences in context, available resources and expected levels of independence and responsibility.

Learning strategies and their application can be taught to students and this is referred to as learning strategy instruction. Mcmillan (2010) advocates for the positive impact of learning strategy instruction on academic performance. She found that learning strategies can be taught to and applied by students in order for effective learning to occur. Gamze, Mehmet & Kamile (2009) conducted a study to investigate the effect of learning strategy instruction on motivation, attitude and achievement in physics courses. They found that learning strategy instruction influences students' performance on problem solving and asking strategic questions, their ability to remember more content, their retention and comprehension level. This shows that teaching students how to learn, which includes selecting appropriate learning strategies and using them accordingly has an impact on their performance.

Some researchers categorize learning strategies according to levels of importance like Hattie, Biggs, & Purdie (1996). These researchers conducted a study to compare rank orderings for approximately 25 learning strategies across cultures. In their findings they indicated that amongst the general strategies some are ranked as more important than others. For example organizing information after learning is ranked higher than seeking peer or teacher assistance. More current research to support or contradict these findings was difficult to find, however I contend that different people learn differently and different tasks require different strategies to be used in different sequences. Schraw & Brooks (1999) argue that it takes more than one learning strategy to see significant change in one's learning, hence a combination of different learning strategies will have to be used. Lebuso (2010, p.12) who conducted a study on learning strategies employed by successful learners in South Africa recently, is of the same view. He found that "different strategies can be used to achieve different learning goals but are more effective if they are used in the right combination. This is because the use of one strategy may support the effectiveness of another strategy". The current study is in agreement with these findings, specifically for science and mathematics subjects, which consist of different sections that

require different strategies for complete understanding. For instance, different learning strategies (like visualising and sketching) may be needed to master Physical Sciences concepts like vector quantities, of which may not be necessary to master chemistry concepts like balancing chemical equations, where only the use of mathematical operations and consistent practice may be sufficient.

Being able to select and use appropriate learning strategies says a lot about the student's ability to regulate their own learning and should have a significant impact on academic success. Some of the research covered in this section is older than ten (10) years, but its findings have been shown to retain continued relevance and applicability even now. There were no current research studies found to contradict the arguments made, rather evolvement of the categorising of learning strategies into more specific constructs have been observed over the years.

Based on the aim to outline learning strategies associated with self-regulation and academic achievement, types of learning strategies that have been investigated recently include cognitive strategies (micro-strategies), metacognition (meta-cognitive strategies), behavioural strategies (social/affective) and resource management strategies (Lebuso, 2010; McMillan (2010);Tinajero et al, 2012). In the current study, three learning strategy constructs were explored and reported on. These are the cognitive strategies, metacognition and resource management strategies as discussed with justification in the section discussing the theoretical framework guiding this study.

**1. Cognitive learning strategies**

Tinajero et al. (2012) found that cognitive styles combined with other learning strategies significantly contributed to the academic achievement of Brazilian University students. Lebuso (2010) and Mcmillan (2010) also found this to be true for South African learners. It is evident that students who employ cognitive strategies in appropriate combinations are expected to perform more successfully than those who do not. None of the reviewed literature offered arguments contrary to that of the positive impact employment of cognitive learning strategies has on academic achievement. The use of these learning strategies in combination with other strategies was explored in this study using questionnaires and the motive behind their use was elaborated on through one-one interviews.

## 2. Metacognitive learning strategies

Planning was found to be one of the most crucial metacognitive processes present in Srl. This includes setting goals, and planning strategies, putting together content knowledge and contextual resources to be used to master an academic task, continuously monitoring and evaluating these for progressive academic performance (Pintrich, 2002; Tinajero et al., 2012; Zimmerman, 2002). A number of studies have also highlighted the role of metacognitive learning strategies in increasing students' motivation, autonomy & responsibility (Eisenberg, 2010; Martinez, 2006; Paris & Winograd, 1990; Ray & Smith, 2010; Schraw et al., 2006). These studies support the argument made in the theoretical framework, that students who use metacognitive strategies, regulate, monitor and evaluate their learning activities towards good academic achievement.

## 3. Resource management Strategies

Resource management strategies involve the regulation and monitoring of an environment that is suitable for learning, peer learning, help seeking and effort regulation (Lebuso, 2010). It is crucial to highlight that the resources available to the students cannot be discussed in isolation from the environment to which both the students and the resources are situated. Mcmillan (2010) found that while learning strategies (including resource management) can be taught to and applied by students; it is only in a learning environment where the learner feels safe, able and valued that effective learning can occur. The learning environment thus offered by the institution and that further created by the lecturer can be looked at as a resource and a significant contributor to the academic success of the learner. The strategies employed by students in utilising the university resources available to them was explored in this study, through interviews to investigate if these have an impact on academic performance.

No empirical studies explicitly focusing on resource management strategies and their impact on academic achievement or learning in general were found.

The issue of resource management may not be easy to generalise amongst different contexts, this is important to highlight because most of the research on Srl and its constructs of which learning strategies belong to has been conducted largely in the first world countries. These countries advance at a much faster pace than the third world African countries where this study was conducted. This is one of the main reasons why most of the research reviewed seems to be old and yet still relevant to context

of interest. With that being said there is no excuse for the limited research reporting on more advanced resource management strategies, with the vast advancements in technology introducing a variety of new study techniques and instruments.

Exploring the instruction and use of these strategies is crucial, as they stand as one of the most important strategies a higher education student needs to possess to attain academic success. As a student, an ex-teacher and an employee in the private sector, I have observed that at higher education institutions most of the necessary resources are readily available. Individuals have more freedom to plan and attend to their activities as they wish, hence this is where resource management strategies (including people, money and time) must be developed first.

## 2.4 Methodologies in Srl

Srl theory and its constructs have been of interest to researchers for decades, as already mentioned, this has led to the use of various research methods. According to Farber (2012, p.9) "Much of the research designs in the collection and analysis of data concerning Srl strategies tends to be defined by qualitative or quantitative data analysis". In the current study both quantitative and qualitative research methods were used sequentially. Zimmerman and Schunk (2011) have a methodology section in their handbook of Srl and performance. This section makes reference to assessment approaches used to investigating Srl developed in the past ten to 25 years. A description of how researchers use newly developed approaches or measurement instruments, such as think aloud protocols, meta-analyses, diary measures, in-depth case studies, exploratory factor analyses, and protocol analysis to describe and pinpoint factors which help us describe or quantify the impact of Srl on individual learning and performance is given. In the paragraphs to follow, a review of studies that have used mixed methods approaches to explore Srl constructs will be given, outlining findings and how these contribute to my study. A critique on the available research and identified gaps conclude this section.

Watson et al. (2004) conducted a study about exploring the motivation and learning strategy constructs, using the Motivated Strategies for Learning Questionnaire (MSLQ) on university students in South Africa. They found that motivational orientation and learning strategies are important predictors

of students with a potential to succeed academically. The trends and relationships between motivation, learning strategies and academic achievement reported in this study were used to inform some of the proceedings of the current study in data collection and analysis.

Effeney et al. (2013) used only one instrument the "Self-regulated learning interview schedule" (SRLIS) to identify the key strategies of Srl and their sources, using a reasonably small sample size of nine students. They found that the more successful students used a wider range of learning strategies more often than the less academically successful students and the teachers were identified as the most common promoters of Srl. In comparison to the current study, their study was quiet small and limited, but the level of detail given on their findings is significant and it informed the current study in the conducting of interviews and data analysis. For example, in their interviews the researchers asked follow up questions to prompt for more detailed responses within the same context.

Some researchers of self-regulated learning are moving towards online research tools, these includes Zimmerman (2008) "Investigating Self-regulation and motivational: Historical backgrounds". Main research Question: How do students become masters of their own learning? Zimmerman is one of the legendary researchers of self-regulated learning whose work has advanced to online assessment tools. Other researchers that have opted for online tools recently include Cho and Heum (2015) who used online surveys to investigate the role of motivation, emotion, and use of learning strategies in students' learning experiences in an online mathematics course. The online survey also contained scales from the MSLQ questionnaire employed in this current study. The researchers in this study argued that despite the limitations they experienced when concerning data collection, their study succeeded in contributing to the body of research explaining Srl with motivation, emotion, and the use of learning strategies.

The research instruments used in the current study (surveys and interviews) remain to be traditional methods of data collection that have proven continued success and validity. Duncan and McKeachie (2005, p.120) on their review of Pintrich (1990) MSLQ had this to say "Because of its flexibility and functionality, we anticipate continued interest in the MSLQ, particularly as researchers, instructors, and student development personnel from different disciplines become more interested in the roles of motivation and self-regulation in student learning and achievement". Local studies that have

successfully employed the MSLQ include Lebuso (2010); Bothma and Monteith (2004); Watson et al. (2004). Their findings were used to inform a significant portion of the proceedings of the current study.

## 2.5 Rationale for the combination of Motivation and Learning strategy constructs

Srl and its applications have been researched intensely in the European countries and it has been found that Srl has a positive impact on academic achievement for students of all ages, but there is not enough research conducted in Africa focusing on motivation and learning strategies combined. Tinajero et al. (2012) in their study of factors affecting academic achievement for Brazilian university students, found that the three main variables significantly affecting academic achievement are cognitive styles, planning strategies and motivational strategies. Yip (2007) argues that students' use of different learning strategies is dependent on their motivation and attitude. He goes on to say that students who are self-motivated tend to use more effective learning strategies and are more persistent in their will to achieve academic goals. Muhammed (2011) conducted a study on the impact of self-efficacy, achievement motivation and Srl strategies on student academic achievement. He views conducting research in this field as important since there is a lack of educational research in this component as an integrated motivational model. The current study aims to contribute to South African literature by adding to this type of knowledge and giving a clear description of the current situation specifically focusing on pre-service teachers majoring in Physical Sciences, and make relevant recommendations moving forward.

The two constructs of interest mentioned above are simply defined by Schraw and Brooks (online article with no date) as the will (Motivation) and the skill (Learning strategies) to take control of one's learning processes towards academic achievement. Zimmerman (1990) as one of the very first researchers of Srl to research this topic said that when students appear to lack both the will and the skill to achieve academically, educators need to apply principles of Srl to promote long term effects towards academic success. According to Mcmillan (2010, p. 2) "The "skill" component comprises the cognitive strategies used to learn, remember and understand material and metacognitive strategies (planning, monitoring, and regulating cognition during learning manifest as information seeking, time management, critical thinking). The "will" component comprises of factors that affect motivation like interest on the subject, goal orientation and task value".

Based on the arguments discussed above it is justifiable to contend that the "will" and the appropriate skills in a conducive and resourceful environment can contribute towards producing successful Physical Sciences teachers and students. The need for conducting context specific studies to explore the role played by these constructs on the performance of pre-service teachers, such as the current study exists.

## 2.6 Summary of the literature review Chapter

To conclude this chapter, a summary of the journey to formulating the current study's theoretical framework as well as the summary of the overall findings made from the reviewed literature is provided.

The Srl theory was shown to be a complex theory, comprising of further multi-constructs, with Motivation and learning strategies selected as the constructs of interest this study focuses on. Reviewed empirical studies on these constructs and their associated components were discussed to support the arguments discussed in the theoretical framework section of this chapter.

The main findings made in this study include the following: Intrinsic motivation and its associated constructs were found to have a positive impact has on academic achievement, with motivation also found to be associated with goal setting, leading to changes in behaviour and academic achievement. The ability to select and use appropriate learning strategies frequently was found to have a significant impact on academic success, with Cognitive, metacognitive and resource management strategies selected as the main strategies explored in this study. Frequent use of cognitive learning strategies, combined with other learning strategies was found to be associated with good academic performance. It was also found that students who use metacognitive strategies; regulate, monitor and evaluate their learning activities towards good academic achievement.

Minimal research on resource management strategies was found. This is a course for concern seeing the vast advancements in technology, introducing a variety of new study techniques and instruments. Learning strategy instruction, which includes selecting appropriate learning strategies and using them accordingly, was also found to have a positive impact on academic performance.

Based on the literature review findings and the identified gaps, there is a need for the current study as it will give further local knowledge, with the potential to assist towards addressing achievement challenges in Physical Sciences.

# CHAPTER 3
# RESEARCH DESIGN AND METHODOLOGY

In this chapter a description of how the current study was designed, approached and carried out is given. The paradigm within which the study was approached, the design, sampling procedures used, the information on participants and their context will be given. The methods of data collection, data analysis and justification of how and why these were considered suitable to be used to answer the research questions will follow. According to Cohen, Manion and Morrison (2007) methods refer to procedures and techniques used in the process of data collection. Furthermore, the purpose of methodology is to then describe approaches and paradigms adopted to help us understand the process used in conducting a particular research study, as done in this chapter.

A report on how the issues of validity and reliability were addressed in both data collection and data analysis, as well as the ethical issues considered in conducting this study is also given in this chapter.

## 3.1 Research Paradigm

Methods used to conduct research are normally derived from the paradigm within which the research is based. Lincoln and Guba (2000) define a paradigm as an investigator's basic belief system or view of how the world should be understood or studied and according to Mackenzie and Knipe (2006) the paradigm informs the way in which knowledge is studied and interpreted. As a scientist I believe in basing conclusions on empirical evidence, which can be obtained through collecting quantitative data, determining relationships and patterns, and then drawing conclusions using statistics. However, this approach has limitations, one being that it does not allow for open ended questions and social behaviors are not easily determined using this approach. Other alternatives include research in the interpretivist's paradigm, where positions are founded on the theoretical belief that reality is socially constructed, thus influenced by culture, social settings and relationships with other people (Cohen & Crabtree, 2007). One of the limitations that research in this paradigm has is that the methods used to

collect data (like observations of dialogs and analysis of existing realities) can pose great difficulty when one needs to take large samples.

In this study the research was approached from a pragmatic view point. The pragmatic paradigm places the research problem as central, applies more than one approach to understand the problem and work towards finding solutions (Mackenzie & Knipe, 2006). According to Wahyuni (2012) instead of questioning ontology and epistemology, supporters of pragmatism start off by looking at the research questions to determine their study framework. Similar principles were applied in this study, which lead to the use of the mixed method approach, where quantitative and qualitative methods of data collection were used in a sequential design, to meet the objectives of the study. Creswell (2003) argued that the pragmatic paradigm provides an opportunity for multiple methods, different world views and different assumptions, as well as different data collection and analysis strategies to be employed. This pragmatic paradigm then informed the selection of the research approach, design and data collection instruments employed to answer the posed research questions and hence meet the objectives of this study as discussed in the paragraphs to follow.

## 3.2 Research Approach

Working in the pragmatic paradigm led to the use of a mixed methods approach to answer the research questions of this study. This approach combines both qualitative and quantitative methods of data collection. Bergman (2008) and Creswell & Plano Clark (2011) are some of the researchers advocating for the use of the mixed methods approach. They argue that many educational problems are best studied by using two or more data sources and using only one data source may provide limited understanding. Jick (1979) and Silverman (2010) have similar views, they also advocate for the use of qualitative and quantitative approaches together as complementary parts of the systematic search for knowledge.

The research was first approached from the positivist perspective to deductively measure the students' motivation and learning strategy profiles. On the second phase, selected students were interviewed to get their personal perspectives to elaborate on the quantitative findings. Surveys were used to collect quantitative data and interviews were used to collect qualitative data as discussed in detail later on in this chapter. The survey and interviews were conducted one after the other in a

sequential design. Interpreted individually first and then collectively to give an in-depth description of the current situation.

## 3.3 Design

A research design is a systematic strategy used to obtain data to answer research questions (Creswell, 2003). Researchers working with the mixed methods approach are expected to choose and describe the mixed methods design best suited to address the outlined research questions and to satisfy the purposes of the study. According to Creswell & Plano Clark (2011), researchers use different approaches for designing their mixed methods studies. Within the wide range of the classified types of typology-based mixed methods designs, the design considered to be best suited for this study was the explanatory sequential design. This design occurs in two different yet interactive phases. It starts with the collection and analysis of quantitative data with an aim to directly respond to the research questions. In the second phase qualitative data is collected and analyzed to support and elaborate on the quantitative data results (Creswell & Plano Clark, 2011).

This mixed methods research design was deemed appropriate for this study as it matched the purpose, research paradigm and research approach. The sequential use of research instruments; surveys and interviews respectively, allowed for the collection and analysis of relevant data to answer the research questions and hence contribute to addressing the problem discussed in chapter 1. The descriptive quantitative data further supported by the interpretive qualitative data ensured achieving the main aim of this study, which was to produce an in-depth description of the pre-service teachers' self-regulated learning processes.

## 3.4 Participants

The target population for this study was the pre-service teachers majoring in Physical Sciences at a tertiary institution in South Africa. The study was therefore conducted on level 1, 2 and 3 Bachelor of Education (B.Ed.) students, majoring in Physical Sciences specialisation. The students were of different ages, races and sexes, they also come from different cultural and socio-economic backgrounds. This meant differences when it came to perspectives regarding learning strategies, languages spoken at home from the language of instruction, motivation profiles and access to/

availability of resources. Research shows that these factors have an impact on student motivation and self-regulated learning processes (Glynn, Brickman, Armstrong &Taasoobshirazi, 2011; Schunk, 2009).

In this study I, the researcher worked with one case of university students consisting of three groups of student teachers majoring in Physical Science education (level 1, level 2 and level 3). This makes three units of analysis which are independent of each other. Each group of students was first studied and analyzed independently to make a contribution to the final in-depth report on the case of pre-service teachers as at tertiary institution in South Africa.

## 3.5 Data collection process

To collect data necessary to answer research questions formulated for this study, there were two sequential phases of participation, that for quantitative data collection and that for qualitative data collection as discussed above. A pilot study was not conducted, however a similar data collection was performed successfully for a similar project on attitudes of pre-service teachers at the same university in the past. The steps followed to achieve the aims of the current study are discussed in this section.

In the first phase, a survey was conducted to collect quantitative data, where all the students in each unit of analysis were given an opportunity to voluntarily participate in the survey. The students were encouraged to participate, but from a targeted total of 178 (181-3 excluded) students, only 127 students participated and 20 were screened out because of incomplete questionnaires leading to a sample size (survey participants) of 107 participants. That is 47 level 1 students, 27 level 2 students and 33 level 3 students.

In the second phase, interviews were conducted to collect qualitative data. In this phase a purposeful sampling procedure was adopted to select interview participants, whose responses were used to elaborate on the survey findings. This is a common non-probability sampling technique with a principle based upon accessibility, and fitness for purpose (McMillan & Schumacher, 2010; Creswell, 2011). According to Daniel (2012, pp. 87-88) “in purposeful sampling the researcher purposely selects the participants from the population on the basis that they fit with the purposes of the study”. This sampling procedure was found to be appropriate at this stage because the main aim was to produce a true reflection of the current situation, rich in both detail and depth. A sample of six students in each level of study was selected for interviews based on their first term marks and their questionnaire

responses, i.e. two top achieving, two bottom achieving and two special cases were selected. Each sample represented the respective unit of analysis, allowing for further analysis of each group. Creswell (2011) argues that purposeful sampling in qualitative research means that the researcher intentionally recruits participants who have experienced the key concept being explored in the study. In advocating for this sampling procedure to be appropriate at this stage, it is important to mention that all the participants selected for interviews showed to have significant motivation profiles and to use a significant number of different learning strategies.

### 3.5.1 Data collection Instruments.

Tools used to collect data to answer research questions are referred to as data collection instruments; these may include interviews, observations, surveys and content analysis (documents) (Cohen, et al. 2007; Creswell, 2008). In this study three data collection instruments were used, two for collecting quantitative data and one for collecting qualitative data: Surveys and interviews respectively. Unger, Keith, Hilling, Gielnik and Frese (2009) argue that surveys are suitable to obtain facts and opinions about a concept from people who are informed on the issue of interest, however if one is concerned about indepth views and opinions it is best to adopt relevent interpretivist's guidelines, which may include the use of interviews and observations. To meet the aims of the current study both surveys and interviews were employed and other researchers advocating for the use of questionnaires and interviews as suitable research tools yielding reliable and credible results include Lombard and Kloppers (2015); Delport and Roestenburg (2011). These are amongst the traditional research instruments which have been used for decades, still continuing to yield valid and trustworthy results in our day as discussed further in section 3.8.

### Quantitative data collection: Questionnaires.

The two instruments used to collect quantitative data were (1) the Science Motivation Questionnaire II (SMQ II) initially developed by Glynn and Koballa (2006) and further reviewed and validated by Glynn, Brickman, Armstrong and Taasoobshirazi (2011). (2) The Pintrich et al. (1991) well known Motivated Strategies for Learning Questionnaire (MSLQ) for assessing college students' motivational orientations and their use of different learning strategies for a college course. The second data collection instrument consists of two parts; the motivation for learning questionnaire with 31 statements and the motivated strategy for learning questionnaire with 50 statements. Only the second part of this questionnaire (focusing on the learning strategies) was used, since there is a more current

questionnaire for assessing motivation aspects specific to science students, i.e. the SMQ II mentioned above. Copies of the instruments are attached in APPENDIX A.

The SMQ II assesses five components of motivation: intrinsic motivation (IM), career motivation (CM), self-determination (SD), self-efficacy (SE), and grade motivation (GM). The students responded to each of the 25 items on a 5 point likert type scale, ranging from 1 (never) to 5 (always) (Glynn et al., 2011).The part of the MSLQ instrument employed assesses nine learning strategy components: Rehearsal (RH), Elaboration (EL), Organization (ORG), Critical Thinking (CT), Metacognitive self-regulation (MC), Time and study Environment (TSE), Effort Regulation (ER), Peer Learning (PL) and Help Seeking (HS). The students responded to each of the 50 items on a seven point likert type scale ranging from 1 (strongly disagree) to 7 (strongly agree). These instruments are specific to science learning and are more relevant to university instruction than general content-area questionnaires on learning strategies and attitudes like the "learning and study strategies inventory" (LASSI). (Glynn et al., 2011; Duncan & McKeachie, 2005.

To measure each of the motivation and the learning strategy scales mentioned above, responses to multiple similar items were added to give a score using an excel spreadsheet. This is referred to as a Likert scale and was used to analyse data generated for each of the three levels of study. Five items make up each of the five motivation scales and between three and 12 items make up the different learning strategy scales, hence specific items were used to explain findings for each of the measured constructs. A table showing a distribution of these items according to their respective scales is attached after the research instruments in Appendix A.

### Qualitative data collection: Interviews.

To collect qualitative data, semi-structured interviews of 18 selected individual participants were conducted after the questionnaires had been administered, coded and captured onto an excel spread sheet. The findings from the analysis of quantitative data were used to determine important points to follow up on through the use of interviews, resulting in the construction of the interview schedule.

The interview schedule consists of 14 questions each formulated to elaborate on each of the motivation and learning strategy constructs measured. This schedule is also attached in Appendix A as part of the research instruments.

The data was collected using Audio tapes and written notes, where only eight out of the 18 participating students gave verbal consent to have their interview conversations recorded on tape. Written notes were then the only form of qualitative data collected for these students.

### 3.5.2 Participation.

The participating University students were observed to be always busy and stressed out trying to juggle meeting deadlines, preparing for tests and practical sessions. It was therefore difficult to get time slots where they would be free to complete research questionnaires, hence the data collection process took longer than expected. The whole process took over a period of two months instead of a proposed maximum of three weeks, during the second semester of year 2015.

The level 2 students were the first to participate in this study. The length of the 2nd questionnaire seemed to be a challenge for most participants at this level of study, with only 28 out of 55 students agreeing to complete the questionnaires. They just browsed through the number of pages and said no thank you, however there were positive outcomes from this experience. Over 80% of the students that did participate gave valid results, and only two questionnaires screened out because they were incomplete. Changes were then made concerning questionnaire administration for the other two classes, which made a positive difference as explained below.

Moving forward, the questionnaires were administered over two days instead of one day and all the level 1 and 3 students that were present on the 14th and the 22nd of September 2015 respectively, participated in the motivation questionnaire. This was pleasing, however the same was not the case with the second questionnaire. Seeing this I took advice from my research mentors from the university to take this a step further and give students the questionnaires to take with and complete in their spare time. The turnout was not as good as with the Motivation questionnaire but there definitely was a significant improvement in numbers compared to the level 2 participation percentages (*57% (47/82) level 1, 40% (25/55) level 2, and 70% (33/47) level 3 students)*.

## 3.7 Data Analysis

After data collection had been completed, the data was “cleaned” to screen out invalid responses and then analyzed to draw meaningful information. In this section all the processes employed to handle, analyze and interpret raw data in the form of likert scale responses and elaborative interview responses are discussed. According to Creswell (2008) data analysis should feed into the research questions, being guided by the research design. In this study three research questions were addressed through a sequential mixed methods design, using two types of data collection instruments. Data generated for each of the groups of students was analyzed per group, where students within each group were further categorized into three groups according to their academic performance in semester 1, to explore relationships between motivational profiles, learning strategies and academic performance. The categories were as follows:

- Academically successful students (60% mark and above)
- Academically average students (50%-59%)
- Academically unsuccessful students (below 50%)

This was done with the help of the students’ academic records provided by the university based on their performance in the specific science modules at the end of the previous semester. Based on experience, at the university level students achieving 60% and above are considered academically successful, 50% - 59% is the average group of students and below 50% are the academically unsuccessful, hence the categories above. In the sub-section to follow, the processes followed to interpret the quantitative and the qualitative data obtained for each group of students, to respond to the three research questions guiding this study as indicated in chapter 1 are discussed.

### 3.7.1 Quantitative Data.

A clean sample was obtained from the collected questionnaires through sorting of the questionnaires to eliminate those that had invalid responses. This was done to ensure that valid and reliable quantitative results were obtained, as to be discussed further in section 3.8. The students’ responses in the form of numbers were then coded and captured onto an excel spreadsheet and further categorized into qualitative motivational and learning strategy scales respectively. These scales are the very same constructs of motivation and learning strategies constituting this study’s theoretical framework as illustrated in Figure 2. The theoretical framework then became the analytical framework used to deductively interpret the collected data. The coding spread sheets used were created with

reference to the Glynn, et al. (2011) article for the SMQ II and the Pintrich et al. (1991) manual for the MSLQ.

The data was further analyzed using basic descriptive statistics tools to get an overall view of the investigated constructs and to identify extreme cases. Univariate analysis, a descriptive analysis tool which involves the examination of one variable (scale for the purposes of this study) at a time across cases or units of analysis, was used to examine the students' responses for each of the motivational and the learning strategy scales (Creswell, 2011). The main characteristics examined for each of the scales were:

1. The distribution, shown through frequency distribution charts
2. The central tendency (Mean, medium and mode)
3. The dispersion, which looks at the spread of the values (range and standard deviation)

This addressed the first and the second research questions, which only looked at identifying the motivation profiles of the participants as well as the learning strategies employed by the participating students. According to Borrego et al. (2009) descriptive statistics allows for giving a description of the situation without addressing any relationships existing between variables or groups, which can be regarded as adequate to address the two research questions in discussion. Examples of analysis by Percentage (%) distribution, associated means and standard deviations for items making up the motivation constructs and the learning strategy constructs are illustrated in the next chapter (table 4.1 and table 4.6 respectively).

The presentation and analysis of data generated is given in chapter 4 in the form of tables and Figures, which give a detailed distribution of responses. To best discuss the findings in chapter 5, some of the categories of response (never, rarely, sometimes, often and always) were fused together when discussing percentage responses to the motivation to learn science questionnaire (SMQ II). That is; the two responses "never and rarely" were grouped together to indicate "negative" motivation profiles, "sometimes" on its own to indicate "neutral" profiles and the other two responses "often and always" were grouped together to indicate "positive" motivation profiles.

To respond to research question number three (*Do motivation and learning strategies as constructs of Self-regulated learning affect academic achievement, and if so how?*) correlations between questionnaire scores and academic results scores were calculated to investigate relationships

existing between motivation factors, learning strategies and performance. According to Cohen, et al. (p. 516, 2007) “a correlation enables a researcher to ascertain whether, and to what extent, there is a degree of association between two variables” and Creswell (2011) says that correlations are used to identify relationships and the effect size (i.e level of association). For the purposes of this study this principle was employed to explore the relationships existing between motivation and academic achievement as well as between learning strategies and academic achievement.

However, no statistically significant correlations (r >1) were found to exist between any of the measured constructs and academic achievement. Responses to each of the motivation and learning strategy constructs constituting the theoretical framework of this study were then analyzed further for each of the three academic performance categories mentioned above. This allowed for further analysis to be performed leading to identification of more explicit motivation profiles and learning strategies used by the participants, associated with their academic performance as discussed in chapter 5.

The data obtained from the likert scales in this study is ordinal; hence only non-parametric statistics could be used to test for significant differences between the mean scores calculated across the three levels of study. Using inferential statistics based on the means for this type of data remains controversial, where many scholars argue that only non-parametric statistics can be used such as the Chi square test, Mann Whitney and the Kruskal- Wallis test statistics depending on the distribution and the number of groups analysed (Velleman & Wilkinson, 1993; Leedy & Ormrod, 2010). Since there were three groups of students with similar distributions, the Kruskal- Wallis statistics was selected as the statistical tool best suited to analyse data collected in this study. The overall mean scores obtained for each of the motivation and the learning strategy scales for each of the three participating groups of students were entered into the Statistical Package for the Social Science program (SPSS), where the Kruskal-Wallis analysis test for significant differences between mean scores across the three levels of study was performed. The results are presented in the next chapter.

### 3.7.2 Qualitative Data.

The qualitative data in this study was collected through the use of interviews. The interview responses were recorded in the form of notes and audio tapes. These were then transcribed and analyzed to elaborate on the questionnaire findings. The techniques adopted to interpret this data are discussed below.

In qualitative research, data analysis is almost inevitably interpretive, it needs careful attention and skill, as the researcher not only looks at written or verbal responses, but non-verbal physical reactions too (Bergman, 2008; Cohen, et al., 2007). To simplify the data analysis process in this study, interviews were purposefully conducted to elaborate on the quantitative data findings. Each of the fourteen questions in the interview schedule was created to address a specific construct from the theoretical framework of this study.

To analyse the interview data in the form of statements, a data analysis tactic referred to as clustering was adopted and adapted slightly to meet the needs of this study. This tactic entails setting items into categories, types or classes of behaviour (Cohen, et al., 2007). The 18 students interviewed were labelled respondent 1 to respondent 18. Similar responses were grouped and tabulated according to the number of students, interview questions and response, i.e 1-3: Q1 refers to the responses of respondents 1-3 to interview question number 1.

The interview statements were then interpreted such that they give an elaborative explanation to the quantitative data findings in response to each of the research questions. Attention was also given to identifying possibly arising factors outside the scope of this research. These together with the responses given to the last question in the schedule (Question no.14 included to give students the opportunity to offer their general opinion about self-regulated learning) were inductively analysed and reported as additional factors not identified through quantitative data collection methods.

To conclude this section, the theoretical framework of this study focuses on the self-regulated learning constructs of Motivation and learning strategies. The research questions and objectives are based on the aim to explore these constructs and to determine their relationship with academic achievement. The quantitative data analysis was approached from the post-positivist perspective to deductively measure the students' motivation profiles and determine the learning strategies they use to study science. The interview data from the second phase was then analyzed to elaborate on the quantitative findings and to further identify other possible factors of motivation not identified through the conducted survey. The same data analysis procedure was followed for each of the three participating groups. The data generated for each group of students is presented and analysed in chapter 4 and the findings are discussed in chapter 5, followed by the summary, implications and concluding chapter (chapter 6).

Table 3.1 below illustrates a summary of how both the quantitative and the qualitative data were obtained and analyzed to respond to each of the current study's research questions.

**Table 3.1**

Links between research questions, research instruments and data analysis tools

| Research Question | Research Instruments | Data Analysis | Justification |
|---|---|---|---|
| 1. What motivation profiles do pre- service science teachers have? | Questionnaires (107) and Interviews (18) | Codes, themes, descriptive-stats, graphs and tables | **Surveys**: To provide an overall idea of the current situation<br>**Interviews**: To probe for elaborative responses |
| 2. What learning strategies do they use to study Physical Sciences and why? | Questionnaires (107) and interviews (18) | Codes, themes, descriptive-stats, tables and graphs | **Surveys**: To provide an overall idea of the current situation<br>**Interviews**: To elaborate on quantitative findings |
| 3. Are there any relationships between the Self-regulated learning constructs (motivation and learning strategies) and academic achievement? | Responses to 1 and 2. First semester results | Correlations, graphs, trend analysis drawn from responses to the first two research questions. | To explore relationships between selected constructs of Srl and academic achievement. |

## 3.8 Validity, Reliability and Rigour.

The findings of this study are specific to the case of pre-service teachers majoring in Physical Sciences at a tertiary institution in South Africa and are not meant for generalising to other contexts. Only the internal validity of the research study was therefore taken into consideration, as to be discussed in this section. According to Leedy and Ormrod (2010, p.97) "The internal validity of a research study is the extent to which its design and the data it yields allow the researcher to draw accurate conclusions about cause-and-effect and other relationships within the data."

The use of the mixed methods approach as done in this study, requires that the issues of validity and reliability be addressed from two different viewpoints, the quantitative and the qualitative point of view. Quantitative research uses a different approach from qualitative research, so much that even the terminology used is different. In quantitative research the terms such as accuracy, consistency and replicability are used, where-as in qualitative research terms like trustworthiness, credibility and dependability are used (Creswell, 2003; Cohen,et al., 2007).

The questionnaires used to collect quantitative data have their validity already been well established using the exploratory factor and the confirmatory factor analysis (Glynn et al., 2011; Pintrich et al., 1991). These research instruments especially the MSLQ have been used by many researchers and have proven to produce reliable and valid results over the years. Researchers advocating for their continued use, include Duncan and McKeachie (2005); Watson et al, (2004).

To further ensure that valid and reliable quantitative results were obtained clean samples were utilized at data analysis. These samples were selected through sorting the questionnaires to eliminate all the questionnaires with invalid responses. Furthermore, the actual questionnaires are designed in such a way that they allow for validity checks to be performed. For example; the motivation and learning strategy scales have statements testing exactly the same aspects using different phrases (for example; statement 3 of the SMQ (II) "Learning Science is interesting" and statement 19 "I enjoy learning science"). Responses to such statements were compared during data analysis to highlight valid responses and to identify inconsistencies. These were also compared with the relevant interview questions testing for similar aspects during analysis, where the credibility and trustworthiness of

interview responses, was first established during the actual interviews and data analysis. In conducting this research, the researcher continuously challenged herself to remain objective and to keep her expectations in check at all times. From the review of literature, it was expected that the academically successful students would give responses indicating higher levels of motivation and more frequent use of learning strategies compared to the academically average and academically unsuccessful students. To prevent this from affecting the findings of this study, the researcher strived to consciously let the respondents speak freely, with minimal interruptions as far as possible, not putting words into their mouths or showing alarming reactions. Cohen et, al (2007); Leedy and Ormord (2010) consider these to be amongst the best tools for obtaining authentic interview data.

In a similar study that I conducted previously with grade 11 learners in a school situated in a rural area, in the southern part of KwaZulu-Natal, I found that addressing the issue of confidentiality had a positive impact on the trustworthiness of learner responses. After the learners had been assured that their names would remain confidential between them and the researcher, they participated more willingly and honestly. In this study confidentiality was also maintained for both ethical and validity purposes. Since the theory of self-regulation is more of an individual and personal responsibility, it is possible for students to tend to be shy and keep some of the details of their practices to themselves. It was thus highly important for them to know that their identities would remain confidential and the information they provided would be handled with integrity. Doing this assisted in ensuring that the students gave honest and credible responses in both the surveys and interviews, even though there were some inconsistencies, resulting to some of the questionnaires being excluded from the study.

## 3.9 Ethical Issues

In the review of literature on ethics the most common ideas associated with ethical issues include morals, norms of conduct and rules for distinguishing between acceptable and unacceptable behavior. As a researcher I believe that my obligation in this regard is to ensure that the participants involved in my study, are treated fairly, with respect and integrity. Their information is handled with care, anonymity and strict confidentiality. Since the mixed methods approach was employed, being sensitive to ethical issues, relevant to participants for their willingness to provide data, handling sensitive information and disclosing the purposes of the research is necessary for both qualitative and quantitative research aspects (Creswell & Plano Clark, 2011). According to Cohen et al. (2007) when looking at ethical issues

there are a set of considerations that researchers should address as they plan their research, but different ethical issues may arise from the kinds of problems investigated by researchers in the humanities and social sciences, and also from the methods used to collect data.

The set of initial considerations one can look at and plan for include; complying with the proper code of conduct in undertaking the research, obtaining informed consent from the gate keepers (those responsible for safeguarding the interests of others and give permission for the research to proceed, like the cluster leader and Dean in the case of this study), participants and parents if dealing with minors, gaining access to and acceptance in the research setting and ensuring anonymity (identity protection) and confidentiality of data that could be traced back to the participants.

With consideration of the above mentioned ethical issues, as the researcher I have tried by all means to address the relevant issues in planning and conducting my research. To do this I first applied for ethical clearance from my University of study. In this application, detail on how I was planning to address the specified ethical issues was given, accompanied by the consent letters of permission to conduct the study from the Dean of the school of education, cluster leader of the Science and technology cluster and the lecturers giving the Physical Sciences modules I am interested in. This application was certified by the commitment to familiarize myself with and sign an undertaking to comply with the University's "Code of Conduct for Research".

After receiving the ethical clearance certificate, each of the participants was also issued with a consent letter. The letter gave my details and the nature of my study. It also outlined the purpose of the study, the role of the participants, awareness of their rights concerning voluntary participation and the right to withdraw from the study at any time, assurance of anonymity and confidentiality of any data that can be traced back to them, like test mark records for example. Informed consent from all the interested participants was then requested to be indicated by a signature and date at the end of the letter. Copies of informed consent letters are attached in Appendix D followed by the ethical clearance certificate attached in APPENDIX E.

# CHAPTER 4
# PRESENTING AND ANALYZING SURVEY AND INTERVIEW DATA

In the previous chapter the research paradigm, design, participants and research instruments employed to collect data necessary to meet this study's objectives were discussed. It was outlined that the researcher used a mixed methods approach involving the use of both quantitative and qualitative approaches in the gathering of data. This involved a sequential use of two types of data collection instruments; questionnaires followed by semi-structured interviews.

In this chapter the data collected and analysed is presented in the form of tables and Figures, following the theoretical framework guiding this study, for each of the three participating levels of study. The chapter is divided into two main sections. In the first section, quantitative data and the analysis performed supported by the relevant interview data is presented. In the second section, a summary of the interview data collected is given.

## 4.1 Students' motivation to study Science

The first aspect of Srl explored was motivation. In this section data generated using the SMQ (ii) for each of three participating levels of study is presented and analysed, supported by the relevant interview data. The results presented in this section are in lieu of research question 1.

Five motivation constructs were explored. An example of analysis by Percentage (%) distribution, associated means and standard deviations for five questions making up the intrinsic motivation construct is illustrated below, to show how the descriptive statistics for each of the five constructs of motivation measured were obtained:

**Table 4.1**

Example of analysis by percentage (%) distribution, associated means and standard deviations for responses to the intrinsic motivation scale for level 1 students

| Intrinsic Motivation Statements | Frequency of occurrence (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Never | Rarely | Sometimes | Usually | Always | Means | SD |
| 1.The Science I learn is relevant to my life | 0 | 0 | 19.6 | 50.0 | 30.4 | 3.1 | 0.7 |
| 3. Learning Science is interesting | 0 | 0 | 10.6 | 23.4 | 66.0 | 3.6 | 0.7 |
| 12. Learning Science makes my life more meaningful | 0 | 2.1 | 17.0 | 44.7 | 36.2 | 3.2 | 0.8 |
| 17. I am curious about discoveries in science | 0 | 4.4 | 15.5 | 35.6 | 44.0 | 3.2 | 0.8 |
| 19. I enjoy learning Science | 0 | 0 | 12.8 | 25.5 | 61.7 | 3.5 | 0.7 |
| | | | | | Grand mean | 3.3 | |

All mean values obtained were above 3, indicating responses between “usually” and “always” .The overall mean for the intrinsic motivation construct (*m=3.3*) also represents responses close to “usually”, indicating that on average the level 1 students usually feel that science is interesting and relevant to their lives, and hence have positive intrinsic motivation.

Similar mean values were obtained for items measuring similar aspects of the intrinsic motivation scale; item numbers 1 and 12 (looking at the relevance of science knowledge to everyday life) have mean values that are very close to each other (*m=3.1 and m=3.2, respectively)*. The same can be said about item number 3 and item number 19 which look at the interest to learn science and the enjoyment experienced during the process (*m=3.6 and m=3.5, respectively*). These findings contribute to the validity of the results obtained for this motivation scale as explained further in section 4.1.5.

## Distribution.

Majority of the respondents scored 4, indicating "always" responses, with a very few scoring 2, indicating "rarely" responses. Table 4.1 shows that over 80% of the students find science interesting and they enjoy learning it, this finding is supported by the standard deviations obtained for each item which are low (*SD <1*), indicating that respondents tended to give similar responses. The item with the highest standard deviation for this scale is item number 4, which looks at the curiosity of students about science discoveries. This shows that not all the students are fascinated by the science discoveries, though they may find the science subject to be interesting.

Following the same procedure, the results obtained for each of the three participating levels of study are presented in the respective tables below. Descriptive comments are given below each table to further explain the presented results.

### 4.1.1 Level 1 students.

**Table 4.2**

Descriptive statistics of level 1 students' responses to the SMQ (II)

| Scales | IM | CM | SD | SE | GM |
|---|---|---|---|---|---|
| Mean | 3.30 | 3.65 | 3.16 | 3.40 | 3.43 |
| Median | 3.40 | 3.80 | 3.20 | 3.40 | 3.60 |
| Mode | 3.60 | 4.00 | 3.00 | 4.00 | 3.60 |
| Standard deviation | 0.54 | 0.41 | 0.59 | 0.54 | 0.46 |
| Range | [2-4] | [2.4-4] | [1.6-4] | [1.4-4] | [2.2-4] |

Table 4.2 shows that the measures of central tendency, mean, median and mode values are similar, with low associated standard deviation values (*SD* <1), indicating that there are small variations between scores. Table 4.2 shows that the students gave average responses between three and four, indicating responses between "usually" and "always". This implies that the students at this level have relatively positive motivation profiles. Career motivation (CM) has the highest scores and self-determination (SD) the lowest (with the largest range of mean scores [1.6-4]). The distribution of mean scores for motivation constructs is best illustrated by the bar graph below.

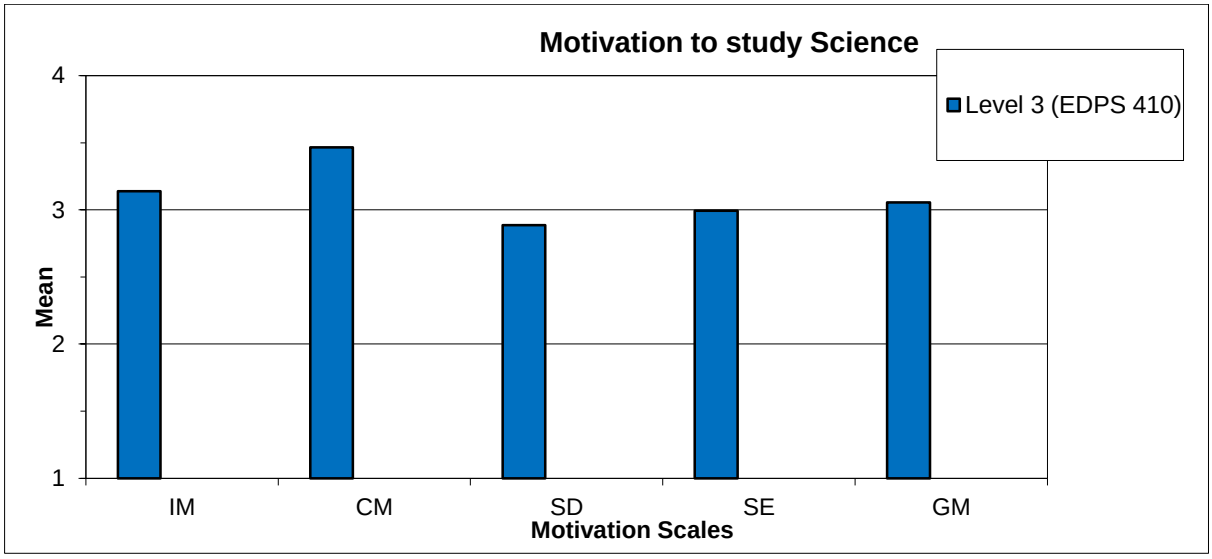


Figure 4.1. Bar chart showing average scores of motivation scales for level 1 students.

The bars representing motivation constructs all fall between 3 and 4, with career motivation having the tallest bar and self-determination the shortest. This is an indication of positive motivation profiles for students at this level of study. Similar findings were obtained from the interview data and what was found from that data which is not visible in this bar chart, is the association between grade motivation (GM), self-efficacy (SE) and enjoyment of studying science. The academically successful students' interview responses indicated higher levels of self-efficacy and these students seemed to be more excited about the science subject and their performance compared to the academically successful students. Respondents 2 and 6 respectively said the following in this regard, "Yes I enjoy science, the chemistry part especially because I get high marks for it" (Respondent no.2 interview, October 22, 2015). "I used to enjoy learning science in high school, because I used to pass it, now I always have too much work to do, it really stresses me out" (Respondent no.6 interview, October 22, 2015). Respondent no. 2 is academically successful and respondent no. 6 is not. (More interview data is summarized in section 4.4).

### 4.1.2 Level 2 students.

**Table 4.3**

Descriptive statistics of level 2 student responses to the SMQ (II)

| Scales | IM | CM | SD | SE | GM |
|---|---|---|---|---|---|
| Mean | 3.12 | 3.59 | 2.92 | 3.13 | 3.26 |
| Median | 3.20 | 3.80 | 2.40 | 2.80 | 3.60 |
| Mode | 3.20 | 3.80 | 3.00 | 3.20 | 3.60 |
| Standard deviation | 0.61 | 0.34 | 0.52 | 0.50 | 0.60 |
| Range | [1.8-4] | [1.8-4] | [1.80-3.80] | [2-4] | [1.60-4] |

The measures of central tendency mean, median and mode scores are similar for constructs; intrinsic motivation, career motivation, self-efficacy and grade motivation. They are all above 3, indicating responses between “usually” and “always”, which shows that on average the level 2 students have positive motivation profiles. Table 4.3 shows that a low mean score, which is different from those obtained for the other constructs was obtained for the self-determination scale (*m=2.9)*. Career motivation was shown to have the highest mean score with the lowest standard deviation (*m=3.6 and SD= 0.3*), indicating a similar view amongst the participants. The bar graph below illustrates these findings more clearly.

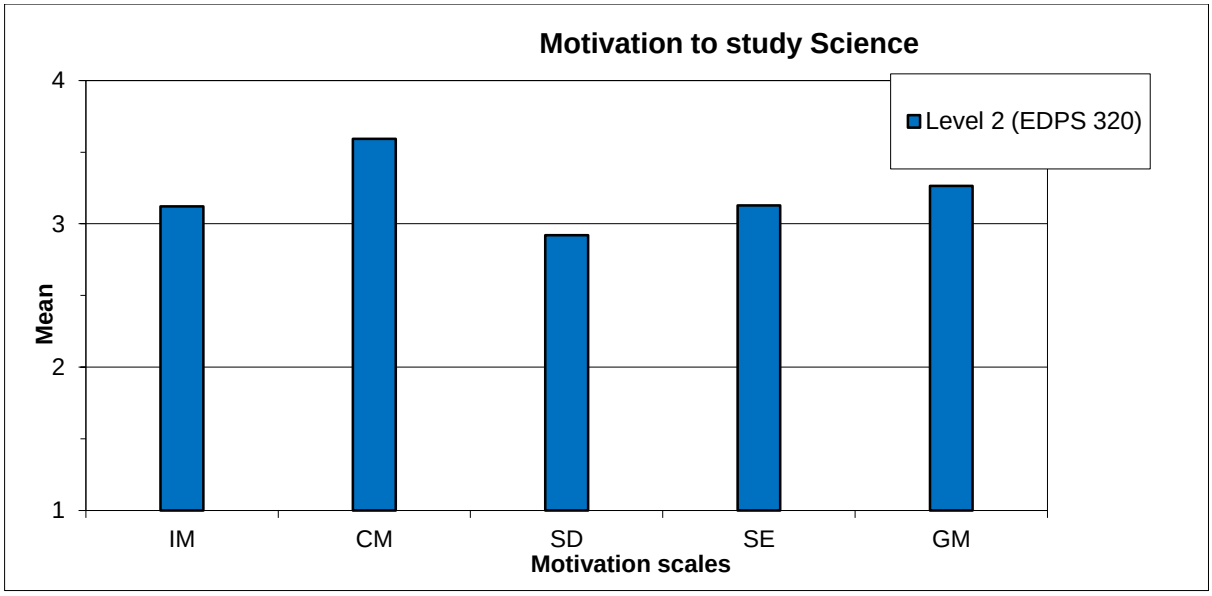


Figure 4.2. Bar chart showing average motivation constructs scores for level 2 students.

The bars representing motivation constructs all fall between 3 and 4, except for the self-determination construct. This is an indication of positive motivation profiles, with high career motivation and low self-determination for students at this level of study.

### 4.1.3 Level 3 students.

**Table 4.4**

Descriptive statistics of level 3 student responses to the SMQ (II)

| Scales | IM | CM | SD | SE | GM |
|---|---|---|---|---|---|
| Mean | 3.14 | 3.47 | 2.8 | 3.0 | 3.1 |
| Median | 3.20 | 3.60 | 3.00 | 3.00 | 3.20 |
| Mode | 3.00 | 4.00 | 3.60 | 3.60 | 3.40 |
| Standard deviation | 0.77 | 0.83 | 0.91 | 0.82 | 0.83 |
| Range | [2-4] | [1.80-4] | [0.40-4] | [1.80-4] | [0.80-4] |

The measures of central tendency mean, median and mode scores are close for constructs; intrinsic motivation, career motivation, self-efficacy and grade motivation. They are all above 3, indicating responses between “usually” and “always”, which shows that on average the level 3 students

have positive motivation profiles. Table 4.4 also shows that the lowest average scores were obtained for the self-determination construct (*m=2.8*), which is the only mean with a score below 3. Career motivation was shown to have the highest average score with a low standard deviation (*m=3 and SD= 0.8*). The bar chart below illustrates these findings more clearly.

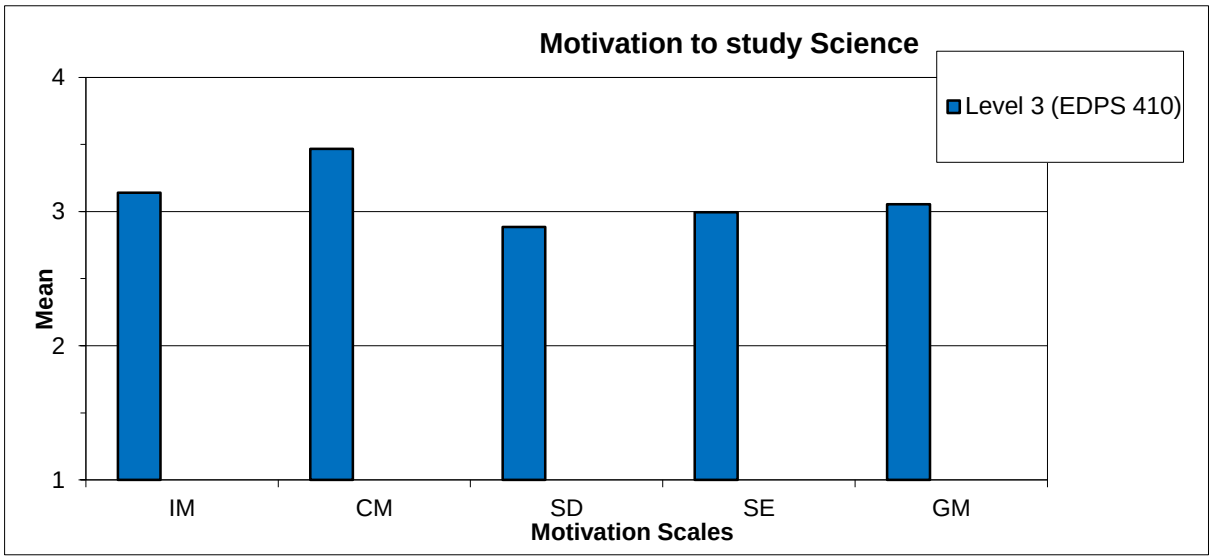


Figure 4.3. Bar chart showing average motivation constructs scores by level 3 students.

### 4.1.4 Comparison of motivation profiles across the three levels of study.

The data generated for each of the three selected groups of students was analysed and reported independently in the previous sections. In this section a combined view of the results obtained for all the three levels of study is presented through the use of motivation profiles and a bar chart showing trends across the three levels of study, as illustrated below:

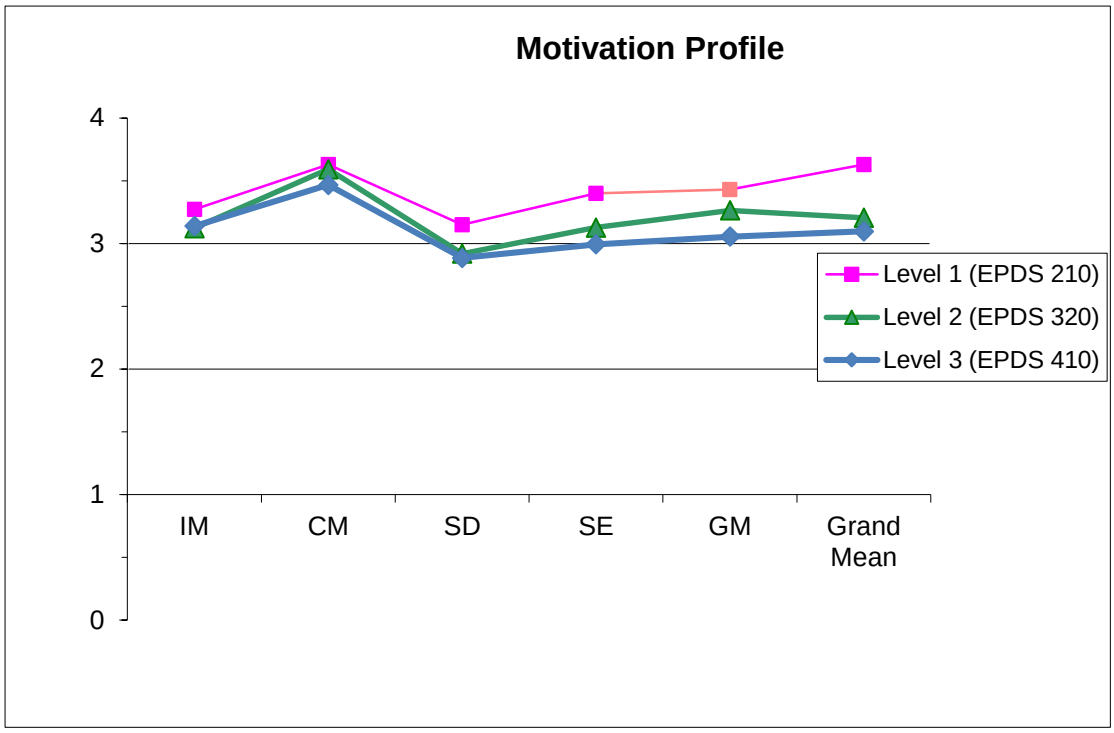


Figure 4.4. Motivation profiles across the three levels of study.

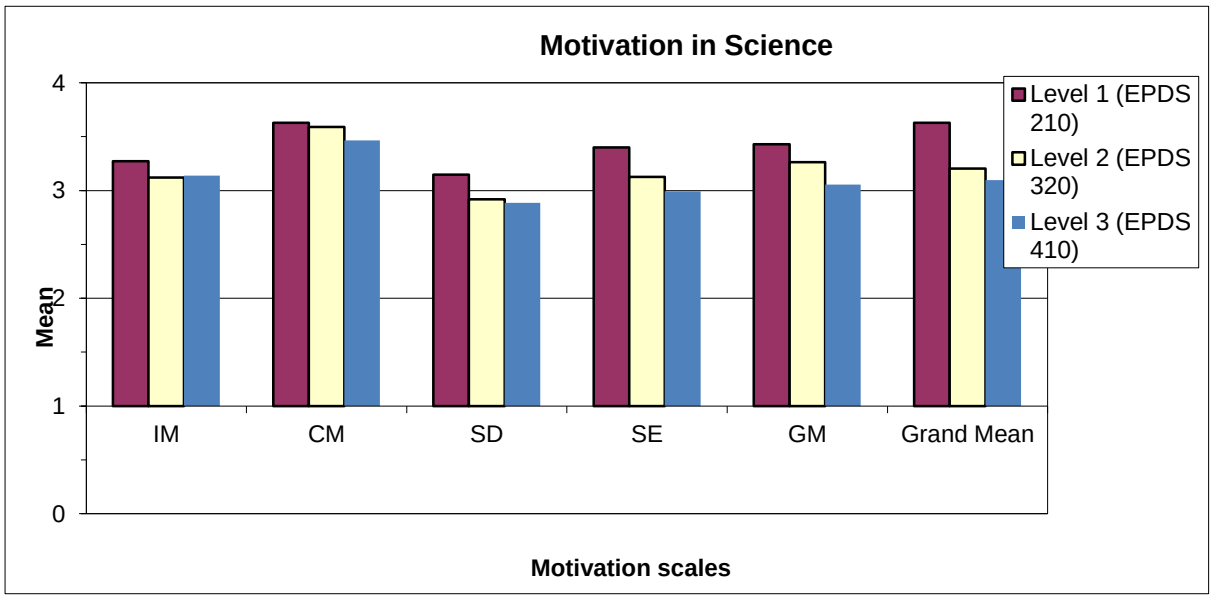


Figure 4.5. Bar chart representation of motivation scales across the three levels of study.

The motivation profile and bar chart show similar trends across the three levels of study. The average scores for all motivation scales are decreasing as one moves up the levels of study (the mean scores are the highest for level 1 students, second highest for level 2's and lowest for level 3's).

Intrinsic motivation is the only differing factor; Level 3 students scored slightly higher average scores than level two students for this scale. The rest of the other motivation constructs follow the same trend. Career motivation is the highest scored construct and self-determination the lowest across all the three levels of study.

The level 1 group of students is the only one with a score above 3 for the self-determination scale, and hence the only group with positive scores for all scales. The results obtained for the level 2 and level 3 students are similar for all motivation constructs. All the mean scores fall between 3 and 4 except for the self-determination scale, indicating that the students gave responses between "usually" and "always". The associated standard deviation values obtained are less than 1, hence considered as statistically low (Gordon, 2007; Leedy & Ormrod, 2010). These results show that on average the pre-service teachers have positive motivation profiles, with career motivation found to be the highest motivating factor and self-determination the least. These findings are supported by the interview data, with further elaborations discussed in section 4.4.

**Inferential Statistics: to test for differences between mean scores.**

To test for differences between the mean scores obtained across the three levels of study, the Kruskal-Wallis test statistic which is a non-parametric statistics best suited to analyse ordinal data for more than two groups of participants was employed as explained in the previous chapter. The results obtained are illustrated in tables 4.5 below.

**Table 4.5**

Kruskal-Wallis analysis test for differences between the motivation mean scores across the three levels of study

**Hypothesis Test Summary**

| | Null Hypothesis | Test | Sig. | Decision |
|---|---|---|---|---|
| 1 | The distribution of Motivation is the same across categories of LevelofStudy. | Independent-Samples Kruskal-Wallis Test | .112 | Retain the null hypothesis. |

Asymptotic significances are displayed. The significance level is .05.

The hypothesis summary shows that there were no significant differences between the motivation profiles of students in the three different levels of study ($p > 0.05$), indicating that the differences in motivation observed were not due to the level of study the students were in.

**4.1.5 Validity and reliability of Results.**

The methods discussed in the previous chapter concerning the establishment of the validity and reliability of the findings made from quantitative data analysis were employed and the findings are reported below, with reference to the example illustrated in table 4.1.

In table 4.1 is illustrated average percentage distributions of responses to each of the statements making up the intrinsic motivation scale for level 1 students. This table shows that item numbers 1 and 12 (looking at the relevance of science knowledge to everyday life) have mean values that are close to each other (*m=3.1 and m=3.2, respectively)*. The same was found for item numbers 3 and 19 which look at the interest to learn science and the level of enjoyment experienced in the process (*m=3.6 and m=3.5, respectively*). This indicates that the findings showing that majority of the participants find science interesting and they enjoy studying it (therefore have positive motivation profiles) can be deemed valid and reliable. The same procedure was followed to compare responses to items testing for the same aspects in each of the five motivation scales through the use of an excel spread sheet.

Replicable and consistent quantitative results were obtained from the utilisations of clean samples selected from the sorting and elimination of questionnaires with inconsistent responses.

The credibility and trustworthiness of interview responses to questions testing for similar aspects, was established during the actual interviews and data analysis. This is further discussed in the discussion section.

## 4.2 Learning strategies used to study science

The second aspect of Srl explored was that of learning strategies, through the presentation and analysis of the quantitative data obtained from the motivated learning strategy questionnaire (MSLQ) as explained in the previous chapter. Relevant interview data is also presented to support quantitative findings. The results presented in this section are in lieu of research question 2.

The same procedure followed for the SMQ (II) data of adding multiple similar items to obtain a score for each of the learning strategy constructs was followed to determine the descriptive statistics employed to analyse the quantitative data obtained for each of the three levels of study. This is shown through the example using the rehearsal learning strategy scale illustrated below:

### 4.2.1 Level 1 students' learning strategies.

**Table 4.6**

Example of analysis by Percentage (%) distribution and associated means and standard deviation for responses to the Rehearsal learning strategy scale.

| Rehearsal learning strategy scale (level 1 students) | Frequency of occurrence (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Statements | Strongly Disagree | Disagree | Slightly Disagree | Neither agree/disagree | Slightly Agree | Agree | Strongly disagree | Means | SD |
| 8. When I study for this class, I practice saying the material to myself over and over | 0 | 6.0 | 2.0 | 24.0 | 26. | 35 | 6 | 5.5 | 1.2 |
| 15. When studying for this module, I read my class notes and the course readings over and over again. | 0 | 2 | 0 | 4.0 | 25 | 55 | 14 | 5.6 | 1.1 |
| 28. I memorize key words to remind me of important concepts in this class. | 2.0 | 0 | 2.0 | 2.0 | 27.0 | 44.0 | 23 | 5.7 | 0.9 |
| 41. I make lists of important items for this module and memorize the lists. | 0 | 0 | 9.0 | 9.0 | 28 | 28 | 26 | 5.0 | 1.2 |
| | | | | | | | Overall mean | 5.4 | |

Table 4.6 shows that majority of the level 1 students, scored between five and six, indicating responses between "slightly agree" and "agree" with using rehearsal learning strategies. Over 65% of

the students said that they read notes over and over again and they memorize key words. This is rather surprising, considering the fact that this is science where they are asked to do calculations and explain phenomena, but they still opt for rehearsing and memorizing.

**Table 4.7**

Descriptive statistics of the level 1 students' (*n=47*) scores to the MSLQ

| Scales | RH | EL | ORG | CT | MC | TSE | ER | PL | HS |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 5.4 | 5.5 | 5.4 | 5.4 | 5.3 | 4.7 | 4.9 | 5.2 | 4.7 |
| Median | 5.5 | 5.7 | 5.5 | 5.6 | 5.4 | 4.6 | 4.8 | 5.3 | 4.8 |
| Mode | 5.8 | 6.0 | 6.0 | 5.8 | 5.4 | 4.3 | 5.0 | 5.7 | 5.5 |
| Standard deviation | 0.8 | 0.8 | 0.9 | 0.7 | 0.6 | 0.7 | 1.0 | 1.0 | 0.9 |
| Range | [4.0-7.0] | [3.3-6.8] | [3.3-7.0] | [4-6.6] | [3.6-6.3] | [3.3-6.4] | [3.5-7.0] | [2.0-7.0] | [2.5-6.0] |

Mean values obtained for the rehearsal, elaboration, organization, critical thinking, metacognitive control and the peer learning strategy scales are above 5, indicating responses between "slightly agree" and "agree". The median and mode responses also fall within the same range. The standard deviations obtained for these learning strategy scales are low (*SD<1)*, indicating that the spread of mean responses is narrow, except for the peer learning scale (*m= 5.2, SD=1 and range: [2-7]).* The range and standard deviation obtained for this scale show a wide variation compared to the other scales. To further look into this scale, during the interviews it was found that majority (4/6) of the academically successful respondents preferred to study individually to avoid interruptions and to save time, unlike the academically average and unsuccessful students that said they preferred to study in groups.

Mean values obtained for the time and resource management strategies, help seeking and effort-regulation were slightly less than 5, indicating that the student responses to using these strategies was "slightly agree". All these scales fall under the resource management strategies, indicating that the level 1 students are not all confident of their use of resource management strategies. The standard deviations obtained for the first two of these scales was low (*SD=0.7 and SD=0.9* respectively), and a higher standard deviation was obtained for the effort regulation scale (*SD=1)*, indicating that the responses to the time and resource management strategies are close to the mean, and the opposite is true for the effort regulation scale. The distributions were further explored through the bar chart below:

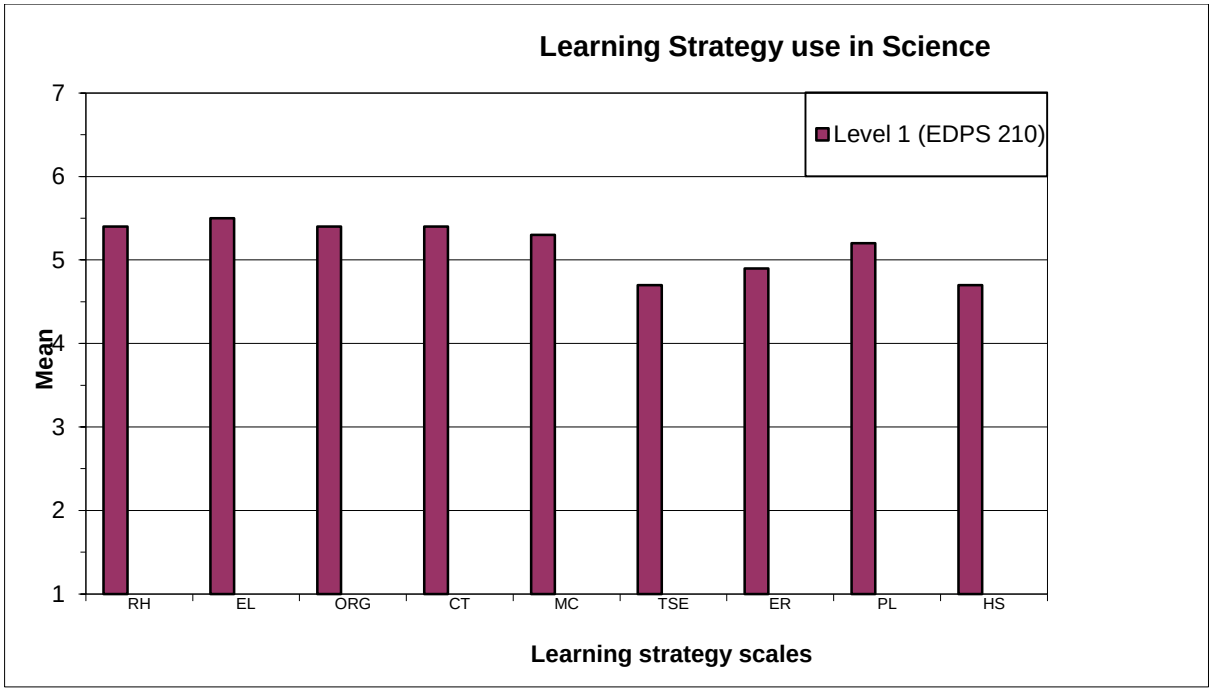


Figure 4.6. Bar chart showing overall learning strategy scores for Level 1 students.

In Figure 4.6 scores between 5 and 6 can be observed for cognitive and metacognitive strategies (rehearsal, elaboration, organization, critical thinking and metacognitive control strategies), indicating responses between "slightly agree" and "agree". Effort regulation is the only metacognitive learning strategy with a score below five. Lower scores (below five) are also shown for resource management strategies (time and resource management as well as help seeking), indicating responses between "neutral" and slightly agree. Peer learning is the only resource management scale with a mean score above five.

Overall, most students were found to acknowledge using cognitive learning strategies, a few using metacognitive learning strategies and the very least using resource management strategies. The interview data showed that the students are aware of the resources at their disposal and that they can use them. Some of the respondents highlighted the main challenge to be managing their time well, hindering them from being able to use the available resources effectively. On the same subject one of the academically average interview respondents from this level of study said the following; "I do use other notes from the internet and library books, but science is not the only module I do and there is not enough time." (Respondent no.4 interview, 22/10/15). This student seems to be aware of the resources at his/her disposal and can use them, the issue may just be the amount of time available or even the way it is managed.

### 4.2.2 Level 2 students' learning strategies.

**Table 4.8**

Descriptive statistics of the level 2 students' (*n=25*) scores to the MSLQ

| Scales | RH | EL | ORG | CT | MC | TSE | ER | PL | HS |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 5.4 | 5.7 | 5.5 | 5.6 | 5.5 | 4.9 | 4.7 | 5.3 | 4.4 |
| Median | 5.5 | 6.2 | 5.3 | 5.6 | 5.5 | 5.0 | 5.0 | 5.3 | 4.8 |
| Mode | 5.8 | 6.2 | 4.5 | 5.2 | 5.8 | 3.5 | 5.3 | 6.0 | 5.0 |
| Standard deviation | 1.0 | 1.1 | 1.0 | 0.7 | 0.6 | 0.9 | 0.9 | 1.3 | 1.4 |
| Range | [4.0-7.0] | [4.2-7.0] | [4.0-7.0] | [4.4-6.6] | [4.3-6.3] | [3.5-6.2] | [3.5-6.2] | [2-6.5] | [1-6] |

Table 4.8 shows that a variety of values were obtained for the measures of central tendency; mean, median and mode, with responses ranging from "neutral" (4) to "Agree" (6). The associated standard deviation values obtained were large (*SD>1)* for five out of the nine learning strategy scales, indicating a wide spread of responses. This is not a surprise considering the fact that university students are expected to be individually responsible for their own learning practices, hence variations in the use of learning strategies are also expected as discussed further in chapter 5.

Mean values obtained for elaboration and critical thinking were slightly less than 6, indicating responses close to "agree". Mean values obtained for rehearsal, organization, peer learning and metacognitive control were slightly less than to 5, indicating responses close to "slightly agree". Mean values obtained for time and resource management strategies, and effort regulation were slightly less than 5, indicating responses close to "slightly agree". Table 4.8 also shows that the help seeking scale has the lowest mean score (*M=4.4*), indicating a "neutral" response, largest standard deviation (*SD=1.4*) and widest range of responses from "strongly disagree" (1) to "agree" (6). This is an indication that these students have different feelings about the use of help seeking strategies in their learning of science.

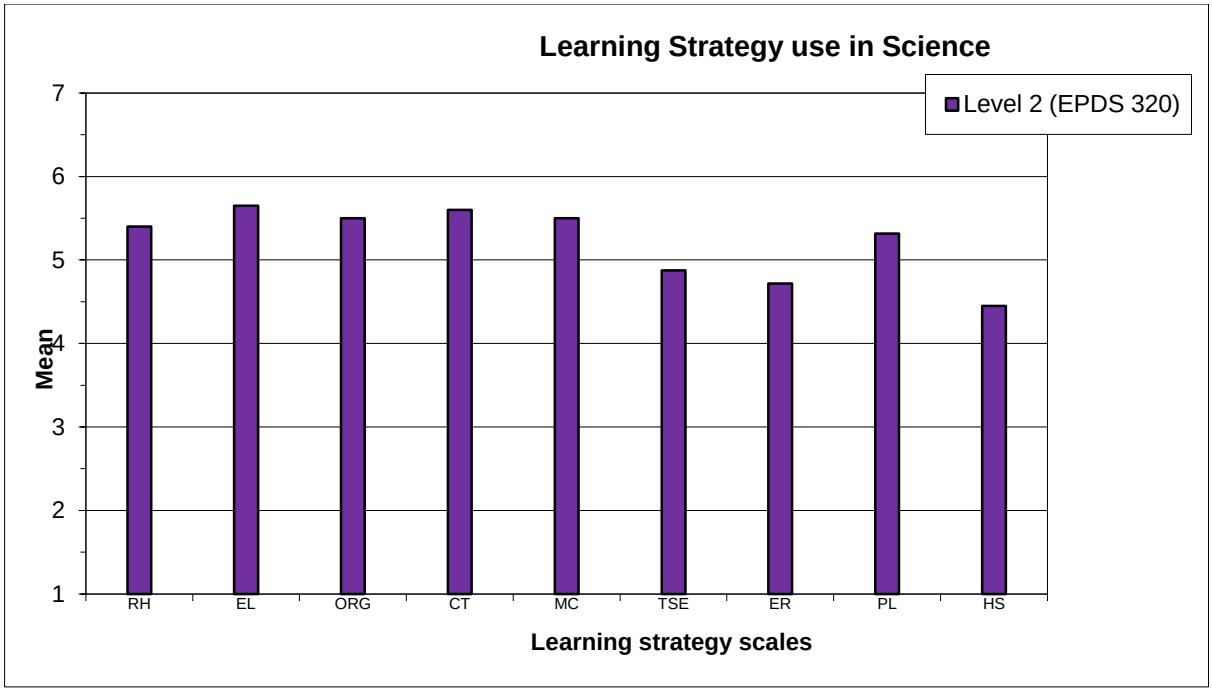


Figure 4.7. Bar chart showing overall learning strategy scores for level 2 students.

The bar chart shows that students agree most with using the following strategies: elaboration, critical thinking, rehearsal, metacognitive self-regulation, organization and peer learning and the least with the following strategies: time and study environment, effort regulation and help seeking.

### 4.2.3 Level 3 students' learning strategies.

**Table 4.9**

Descriptive statistics of the level 3 students' (*n=33*) scores to the MSLQ

| Scales | RH | EL | ORG | CT | MC | TSE | ER | PL | HS |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 5.3 | 5.4 | 5.3 | 5.1 | 5.1 | 4.7 | 4.9 | 4.9 | 4.6 |
| Median | 5.5 | 5.7 | 5.3 | 5.4 | 5.2 | 4.8 | 4.8 | 5.0 | 4.5 |
| Mode | 5.5 | 6.2 | 5.3 | 5.8 | 5.4 | 4.9 | 4.8 | 4.7 | 5.3 |
| Standard Deviation | 1.1 | 1.0 | 0.8 | 0.8 | 0.7 | 0.8 | 1.0 | 1.2 | 0.9 |
| Range | [3.5-6.5] | [2.7-6.8] | [3.0-6.5] | [2.6-6.4] | [2.8-6.2] | [3.1-6.5] | [3.3-7] | [2-6.7] | [3-6] |

Mean values obtained for the rehearsal, elaboration, organization, critical thinking, metacognitive control and effort regulation scales are slightly higher than 5, indicating responses close to slightly agree. The median and mode scores are slightly higher than the mean scores, showing a variation in student responses. The standard deviations obtained for majority of these learning strategy scales are high (*SD>1)* also indicating a large variation in student responses, except for the organization, critical thinking time and study management, and help seeking scales (*SD<1).*

Mean values obtained for the time and resource management strategies, help seeking and peer learning were slightly less than 5, indicating responses close to slightly agree. The standard deviations obtained for majority of these scales were low, only higher for the peer learning scale (*SD=1.2).* During the interviews one of the academically unsuccessful respondents from this level of study said thus, "Studying in a group or on my own does not make much of a difference for me, I get the same marks". (Respondent no.13 interview, 30/09/15). This is an interesting view, which could add to explaining the large variation in mean scores obtained for the peer learning strategy scale at this level of study.

In summary the data presented above shows that level 3 students are not all confident of their use of resource management strategies. Peer learning was once again shown to have the largest spread of responses and again during the interviews it was found that majority (5/6) of the academically successful respondents preferred to study individually, which is contrary to some of the academically average and unsuccessful students that said they preferred to study in groups.

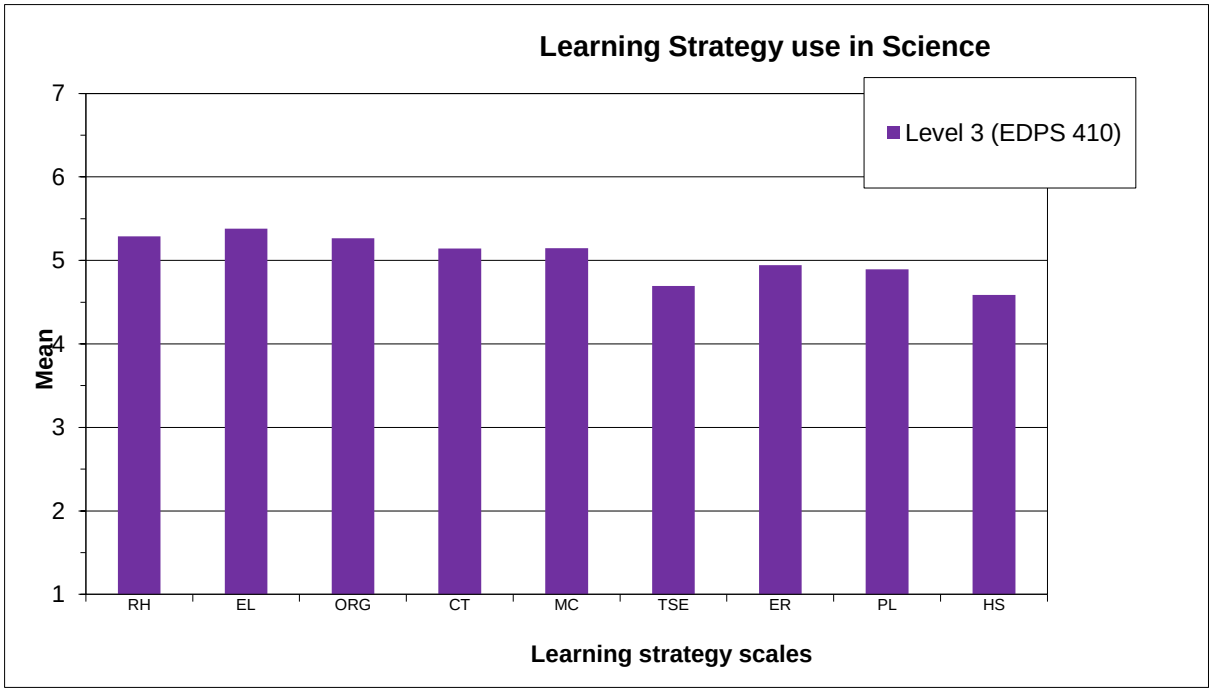


Figure 4.8. Bar chart showing overall learning strategy scores for Level 3 students.

This Bar chart gives an overview showing scores between 5 and 6, indicating responses between slightly agree and agree for all cognitive and metacognitive strategies. Lower scores (below 5) are shown for resource management strategies, indicating responses between "neutral" and slightly agree.

### 4.2.4 Learning strategy use across the three levels of study.

In the previous section data generated for each of the three internal cases was reported and analysed independently. In this section a holistic view of the results obtained for all the three cases is presented through the use of a learning strategy profile and a bar chart showing trends across all levels of study, as illustrated below:

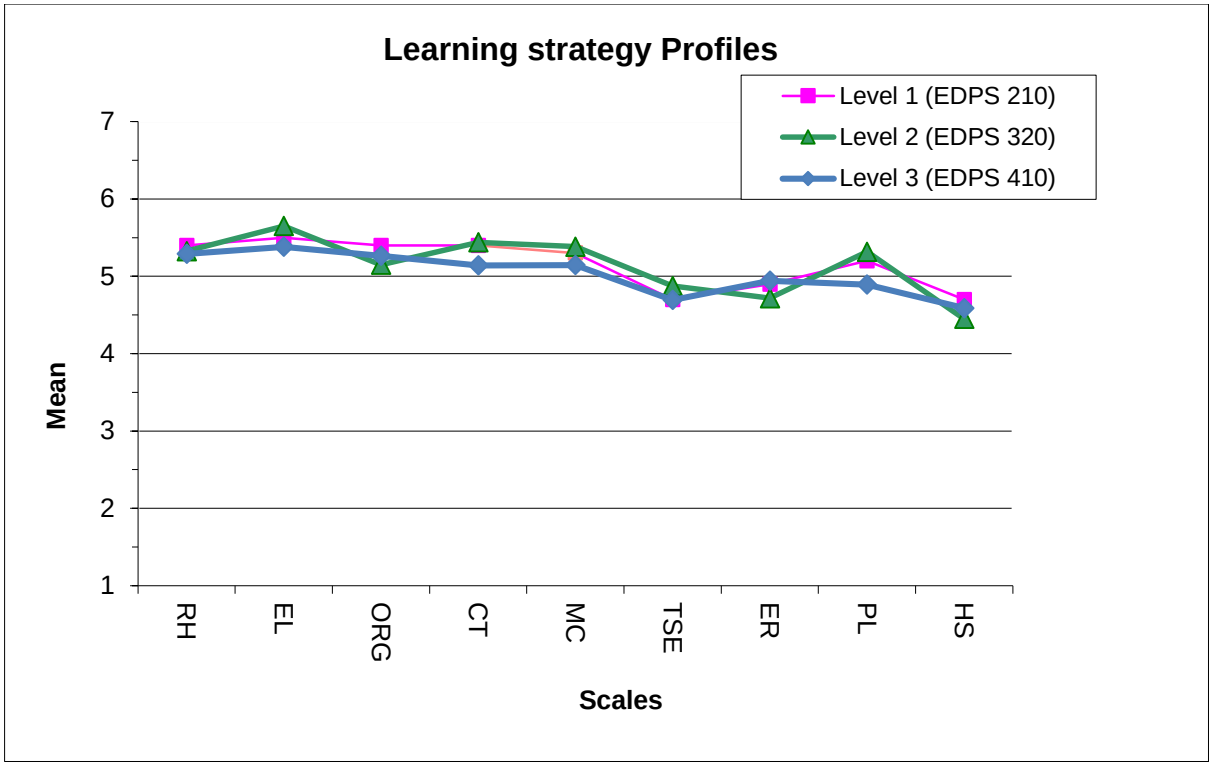


Figure 4.9. Profiles showing learning strategy use across the three levels of study.

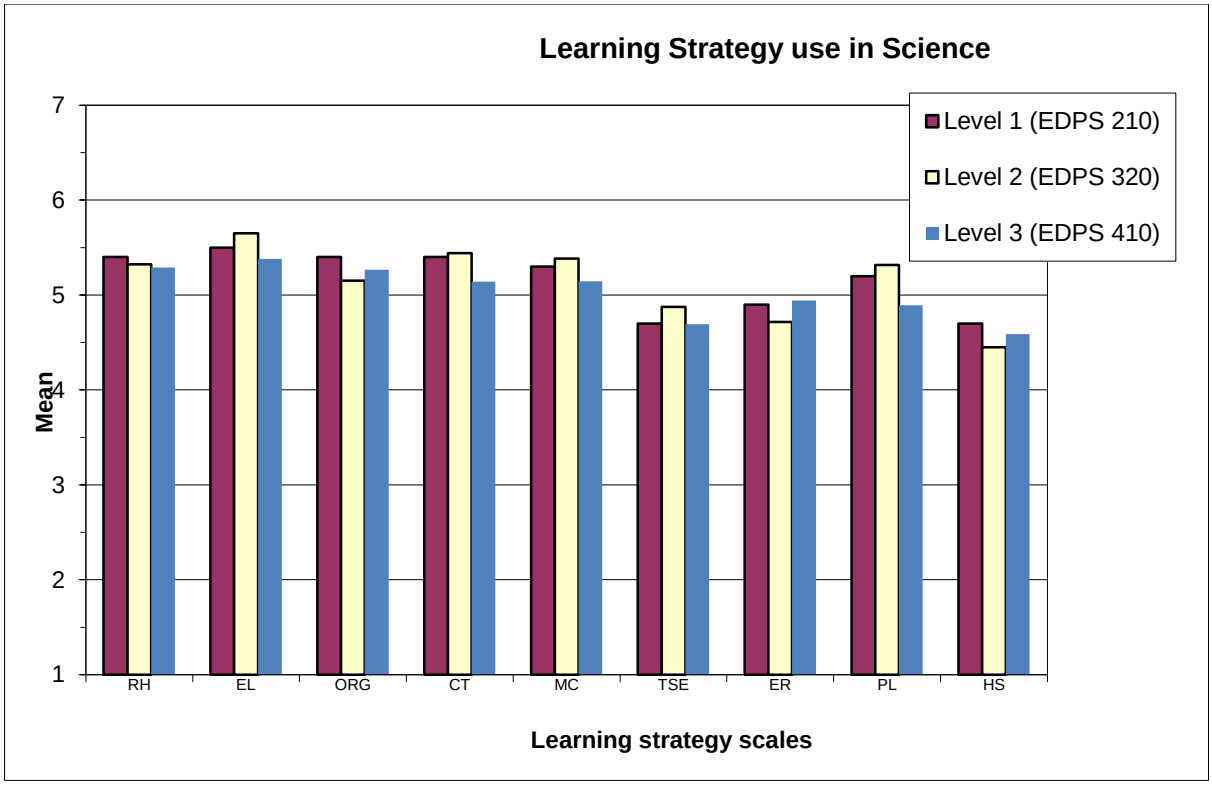


Figure 4.10. Bar chart representation of learning strategy scales across the three levels of study.

The learning strategy profile and bar chart show varying trends, indicating a variation in the use of learning strategies by students across the three levels of study. The resource management strategies: help seeking, time and study environment strategies were scored low (between 4 and 5) by students across all three levels of study. Higher bars (scores between 5 and 6) were obtained for the use of cognitive learning strategies, indicating responses between “slightly agree” and “agree” for students across all three levels of study.

The Figures also show that level 2 students have higher scores for the majority of learning strategy scales except for effort regulation and help seeking, when compared to the other two levels of study. This is shown clearer by the bar chart; the bars representing the resource management strategies on the right are shorter than the cognitive and metacognitive learning strategy bars on the left. This result was supported by the interview data, where all the respondents agreed that they do use cognitive learning strategies. However, majority of interviewees seemed to be shocked by the interview questions addressing metacognitive learning strategies.

The interview data obtained also revealed that the interviewed students are aware of the resources at their disposal and can use them, whether the use is managed appropriately or not is questionable. The successful students said they often use the other information on the internet, tutorials, You-Tube videos and library books, but they said nothing much about efficiently managing the use of these resources.

The academically average and the academically unsuccessful students also said that they make use of the same resources but they stressed the issue of time and working under pressure as the main challenge limiting them from taking full advantage. Some interview respondents also stressed the fact they have no choice but to always work very closely to the deadlines because Physical Sciences is not the only module they have to attend to.

To conclude this section; a more frequent use of cognitive learning strategies to study science was observed, compared to the use of metacognitive and resource management strategies, by students across the three levels of study. Majority of the students were found to rely more on rehearsing and memorizing key words, which came as a surprise seeing that science is more of a practical subject with a lot of calculations used to explain phenomena. The main reason behind students studying this way was found to depend mostly on the available time and the amount of work to be done, with another possibility being due to the lack of experience in the use of metacognitive learning strategies and resource management strategies.

**Inferential Statistics: to test for differences between mean scores.**

The same procedure as the one followed for the motivation data was also applied in this section to test for significant differences between the mean scores across the three levels of study. The overall mean scores obtained for each of the learning strategy scales for each of the participating groups of students were entered into SPSS, where the Kruskal-Wallis analysis test was performed. The results obtained are illustrated in tables 4.10.

**Table 4.10**

Kruskal-Wallis analysis test for differences between learning strategy mean scores across the three levels of study

**Hypothesis Test Summary**

| | Null Hypothesis | Test | Sig. | Decision |
|---|---|---|---|---|
| 1 | The distribution of LearningStrategies is the same across categories of LevelofStudy. | Independent-Samples Kruskal-Wallis Test | .274 | Retain the null hypothesis. |

Asymptotic significances are displayed. The significance level is .05.

The hypothesis summary shows that there were no significant differences between learning strategies used by students from the three different levels of study (p >0.05), indicating that the differences observed were not due to the level of study the students were in.

**4.2.5 Validity and reliability of Results.**

The methods discussed in the previous chapter concerning the establishment of the validity and reliability of the findings made from quantitative data analysis were employed and the findings are reported below, with reference to the example reported in table 4.6 above.

Table 4.6 illustrates average percentage distributions of responses to each of the statements making up the rehearsal learning strategy scale for level 1 students. This table shows that item numbers 8 and 15, “When I study for this class, I practice saying the material to myself over and over” and “When studying for this module, I read my class notes and the course readings over and over again” respectively, have mean scores that are very close to each other (*m=5.5 and m=5.6, respectively)*. Similar results were obtained for item numbers 28 and 41, “I memorize key words to remind me of important concepts in this class” and “I make lists of important items for this module and memorize the lists” (m=5.7 and m=5.0, respectively). All the results quoted above fall between 5 and 6, indicating responses between “slightly agree” and “agree”.

The same procedure was followed to compare responses to items testing for the same aspects in each of the other eight learning strategy scales through the use of an excel spread sheet. Replicable and consistent responses were obtained from the questionnaires making up the clean samples for each of the three internal cases making up the case of university pre-service teachers studied. In this section there were some inconsistencies, of which the respective questionnaires were eliminated for the purposes of obtaining clean samples. As a researcher I once again acknowledge the possibility of limitations this could pose to the current study, but valid findings were prioritised over having large volumes of data which could comprise the validity and reliability of the very same study.

The credibility and trustworthiness of interview responses to questions testing for similar aspects, was established during the actual interviews and data analysis. The findings are further explained in the discussion section.

## 4.3 Relationships between the Srl constructs and academic achievement

To explore relationships between the Srl constructs of interest (motivation and learning strategies) and academic achievement, two methods were employed as discussed in the previous chapter. In this section the process is briefly recapped and the results obtained are presented. The results presented in this section are in lieu of research question 3.

Firstly; correlations between the participants' semester 1 final marks and responses scored for each of the motivation and the learning strategy constructs were calculated. The correlation coefficient values ($-0.01 > r < 0.5$) obtained indicated that there were very weak or no significant relationships existing between the academic achievement and any of the motivation or learning strategy scales (Cohen et al., 2007; Leedy & Ormrod, 2010). All the correlation coefficients obtained were tabulated and attached in APPENDIX C.

The students were categorized into three groups according to their academic performance to possibly identify relevant relationships as discussed in chapter 3 and the results obtained are presented below.

### 4.3.1 Motivation and academic achievement.

The data obtained from each of the three levels of study first analysed independently and then consolidated to highlight observed relationships, concerning the motivation and academic achievement of the pre-service teachers measuring in Physical Sciences at a tertiary institution in South Africa is presented below.

**Level 1 students.**

First semester performance overview for Level1 students:

- Academically successful students : 35.4%
- Academically average students : 44.3%
- Academically unsuccessful students : 20.3%

The overview shows that there are more academically successful and average students, than the less successful students at this level of study, which from my experience is not common in typical Physical Sciences classes. The significance of this is discussed in the next section, where the findings across all the three participating levels of study are compared.

After grouping the students' responses, the procedure followed to determine percentage (%) distributions at the beginning of the data analysis in this study was followed to determine percentage distributions for each of the three categories of students. The results obtained are represented below:

**Table 4.11**

Percentage distribution of level 1 student responses to the SMQ (II) for each of the three academic performance categories

| Scale | | Never (0) | Rarely (1) | Sometimes (2) | Usually (3) | Always (4) |
|---|---|---|---|---|---|---|
| Intrinsic Motivation | Academically successful students( n = 17) | 0 | 0 | 0 | 60% | 40% |
| | Academically average students (n=21) | 0 | 0 | 9% | 50% | 41% |
| | Academically unsuccessful students (n=9) | 0 | 0 | 11% | 46% | 33% |
| Career Motivation | Academically successful students | 0 | 0 | 0 | 20% | 80% |
| | Academically average students | 0 | 0 | 0 | 27% | 73% |
| | Academically unsuccessful students | 0 | 0 | 0 | 11% | 89% |
| Self-determination | Academically successful students | 0 | 0 | 0 | 40% | 60% |
| | Academically average students | 0 | 0 | 23% | 41% | 36% |
| | Academically unsuccessful students | 0 | 0 | 22% | 56% | 22% |
| Self-efficacy | Academically successful students | 0 | 0 | 0 | 40% | 60% |
| | Academically average students | 0 | 5% | 5% | 54% | 36% |
| | Academically unsuccessful students | 0 | 0 | 0 | 67% | 33% |
| Grade Motivation | Academically successful students | 0 | 0 | 0 | 40% | 60% |
| | Academically average students | 0 | 0 | 10% | 36% | 54% |
| | Academically unsuccessful students | 0 | 0 | 0 | 56% | 44% |

**Academically successful students.**

The students in this category scored between 3 and 4, indicating “usually” and “always” responses for all motivation scales. This is an indication of positive motivation profiles for all academically successful students at this level of study.

**Academically average Students.**

The academically average students gave a large variety of responses. They scored between 2 and 4 for the intrinsic motivation, career motivation, self-determination and grade motivation scales, indicating responses "sometimes", "usually" and "always". Self-efficacy was the only scale with scores below 2. This scale measures the individual's beliefs in their ability to succeed and 5% of the students scored 1, indicating "rarely" responses to statements testing for this scale.

**Academically unsuccessful Students.**

Table 4.11 shows that 22% of students in this category at this fist level of study scored 2 for the self-determination scale and 11% gave similar responses for the intrinsic motivation scale, indicating "sometimes" responses. They scored between 3 and 4 for career motivation, self-efficacy and grade motivation scales, indicating "usually and "always" responses like the academically successful students. This is a surprise seeing their poor academic performance in this science module. This can be explained by the frustrations expressed by two of the academically unsuccessful students interviewed. One of these students responded to the interview question asking if he believed that he can master science knowledge and skills by saying thus, "I really love Physics and I used to get good marks in high school, but here I am struggling to cram all the work before tests and exams, so I really don't know" (Respondent no.5 interview, October 22, 2015). This response talks to both motivation and learning strategy aspects and is discussed further in the discussion section.

To summarise findings for this level of study; the academically successful students scored between 3 and 4, in all motivation scales, indicating an association between positive motivation profiles and academic achievement. The academically average and unsuccessful students gave a variety of responses, some scored 1, others 2 and others 3 and 4, indicating a variety of motivation profiles. Career motivation was once again shown to be the highest motivating factor for all three groups of students at this level of study (over 80% students gave "always" responses to this particular motivation scale).

**Level 2 students.**

First semester performance overview for level 2 students

- Academically successful students : 12%
- Academically average students : 50%
- Academically unsuccessful students : 37%

A majority of the students at this level of study are academically average, followed by the unsuccessful students and then the successful students. This is a different distribution from that of the level 1 students, but the same calculations were performed for the data collected. Percentage distributions obtained for each of the three student' categories were tabulated as in table 4.11 above and then attached in APPENDIX C. Below are comments to the results obtained:

**Academically successful students.**

The students in this category scored between 3 and 4, indicating responses between "usually" and "always" for all constructs of motivation explored, which shows that these students have positive motivation profiles. 75% of the students in this category scored 4 for the grade motivation scale and the other 25% scored 3. This construct of motivation was shown to be the highest motivating factor for these students, which is not a surprise for high achievers.

**Academically average students.**

All students in this category scored between 3 and 4, indicating responses between "usually" and "always" for all motivation components except for the 9% that gave "sometimes" responses for the self-determination scale. No component was identified as the highest motivating factor compared to the others.

**Academically unsuccessful students.**

The students in this category gave a wide range of scores from 2 to 4, indicating responses "sometimes", "usually" and "always". 50% of the students scored between 3 and 4 for intrinsic

motivation, indicating “usually and “always” responses. Over 60% students scored between 3 and 4 for self-efficacy, self-determination and grade motivation scales, the other 40% scored 2, indicating “sometimes” responses for these motivation scales. 90% of the students scored between 3 and 4 for career motivation, indicating “usually and “always” responses, indicating this scale to be the highest motivating factor for majority of students in this category.

To summarise findings for this level of study; the academically successful students scored between 3 and 4, in all motivation scales, indicating an association between positive motivation profiles and academic achievement. The academically average and unsuccessful students gave a variety of responses, some scored 1, others 2 and others 3 and 4, indicating a variety of motivation profiles. Career motivation was shown to be the highest motivating factor for majority of the academically unsuccessful students at this level of study.

**Level 3 students.**

First semester performance overview for Level 3 students

- Academically successful students : 13%
- Academically average students : 53%
- Academically unsuccessful students : 34%

The overview shows that there are a few academically successful students compared to the other two types of students at this level of study.

The results obtained for this level of study can be said to be similar to those obtained for the level 1 students and can thus be summarised thus; the academically successful students also scored between 3 and 4, in all motivation scales, indicating an association between positive motivation profiles and academic achievement. The academically average and unsuccessful students gave a variety of responses, some scored 1, others 2 and others 3 and 4, indicating a variety of motivation profiles. Career motivation was once again shown to be the highest motivating factor for all three groups of students at this level of study. The table showing percentage distributions is attached in APPENDIX C.

### 4.3.2 Relationship between learning strategies and academic achievement.

In this section a report on what was found during the analysis of data to explore relationships between learning strategy scales and academic achievement for each of the three student categories mentioned above is given.

Firstly, an example showing how the % distributions (attached in APPENDIX C) determined for each of the learning strategy scales were further condensed into the three main Srl learning strategy constructs (Cognitive learning strategies, Metacognitive and Resource management learning strategies) constituting this study's analytical framework is given using the cognitive learning strategy construct for academically successful students as an example.

**Table 4.12**

Example of analysis by percentage (%) distribution; responses to learning strategy scales making up the cognitive learning strategy construct for level 1 academically successful students

| Learning strategy scales | % Distribution | | | | | | |
|---|---|---|---|---|---|---|---|
| | Strongly Disagree (1) | Disagree (2) | Slightly Disagree (3) | Neither agree/disagree (4) | Slightly Agree (5) | Agree (6) | Strongly disagree (7) |
| Elaboration | 0 | 0 | 0 | 0 | 17 | 71 | 16 |
| Rehearsal | 0 | 0 | 0 | 0 | 35 | 59 | 6 |
| Organisation | 0 | 0 | 6 | 6 | 12 | 53 | 23 |
| Grand Average | 0 | 0 | 2 | 2 | 21 | 61 | 14 |

The grand average percentages reported in Table 4.12 represent the average scores for the cognitive learning strategy construct. It shows that 75% (61%+14%) of the academically successful students scored between 6 and 7 for the cognitive learning strategy scale, indicating “agree” and “strongly agree” responses. This indicates that 75% of the academically successful students use cognitive learning strategies.

The same procedure was followed for the metacognitive and the resource management strategies, the results obtained are presented using tables for each of the participating levels of study as recorded below.

**Level 1 students.**

**Table 4.13**

Percentage distribution of responses to Learning strategy constructs for Level 1 students’

| Construct | | Strongly Disagree (1) | Disagree (2) | Slightly Disagree (3) | Neither agree / disagree (4) | Slightly Agree (5) | Agree (6) | Strongly Agree (7) |
|---|---|---|---|---|---|---|---|---|
| Cognitive Learning Strategies | Academically successful students | 0 | 0 | 2% | 2% | 21% | 61% | 14% |
| | Academically average students | 0 | 0 | 3% | 12% | 36% | 44% | 5% |
| | Academically unsuccessful | 0 | 0 | 0 | 20% | 30% | 43% | 7% |
| Metacognitive strategies | Academically successful students | 0 | 0 | 0 | 9% | 50% | 41% | 0 |
| | Academically average students | 0 | 0 | 0 | 12% | 43% | 46% | 0 |
| | Academically unsuccessful | 0 | 0 | 0 | 15% | 30% | 50% | 0 |
| Resource management strategies | Academically successful students | 0 | 0 | 6 | 26% | 37% | 28% | 3 |
| | Academically average students | 0 | 0 | 5% | 31% | 35% | 27% | 2% |
| | Academically unsuccessful | 0 | 3 | 0 | 35% | 30% | 30% | 2% |

Table 4.13 shows that 75% of the academically successful students scored between 6 and 7 for the cognitive learning strategy scale, indicating “agree” and “strongly agree” responses. 41% students gave the same responses for the metacognitive learning strategy scale and only 31 % for the resource management strategy scale.

This table also shows that 49% of the academically average students scored between 6 and 7 for the cognitive learning strategy scale, indicating “agree” and “strongly agree” responses. 46% students gave the same responses for the metacognitive learning strategy scale, which is a higher percentage than that observed for the academically successful students. Only 29% students gave the same responses for the resource management strategy scale.

50% of the academically unsuccessful students scored between 6 and 7 for the cognitive and the metacognitive learning strategy scales, indicating “agree” and “strongly agree” responses. Only 32% of these students gave the same response for the resource management strategy scale.

In summary, the academically successful students were found to use more cognitive learning strategies, followed by the metacognitive learning strategies, when compared to the average and the less successful students at the same level of study. For the use of resource management strategies, low scores were obtained for students across all the categories (average of 37% and below).

**Level 2 and 3 students.**

The same procedure followed above was employed for the data collected from the Level 2 and 3 students. The results are presented in the following tables, respectively:

**Table 4.14**

Percentage distribution of responses to Learning strategy constructs for Level 2 students

| Construct | | Strongly Disagree (1) | Disagree (2) | Slightly Disagree (3) | Neither agree / disagree (4) | Slightly Agree (5) | Agree (6) | Strongly Agree (7) |
|---|---|---|---|---|---|---|---|---|
| Cognitive Learning Strategies | Academically successful students | 0 | 0 | 0 | 0 | 11% | 22% | 67% |
| | Academically average students | 0 | 0 | 0 | 0 | 44% | 33% | 22% |
| | Academically unsuccessful | 0 | 0 | 0 | 17% | 28% | 50% | 5% |
| Metacognitive strategies | Academically successful students | 0 | 0 | 0 | 33% | 16.5% | 35% | 0 |
| | Academically average students | 0 | 0 | 0 | 0 | 17% | 67% | 17% |
| | Academically unsuccessful | 0 | 0 | 0 | 0 | 42% | 58% | 0 |
| Resource management strategies | Academically successful students | 0 | 0 | 8.3% | 8.3% | 42.1% | 33% | 8.3% |
| | Academically average students | 0 | 0 | 8 | 0 | 50% | 50% | 0 |
| | Academically unsuccessful | 4% | 4% | 0 | 25% | 46% | 13% | 8% |

**Table 4.15**

Percentage distribution of responses to Learning strategy constructs for level 3 students

| Scale | | Strongly Disagree (1) | Disagree (2) | Slightly Disagree (3) | Neither agree / disagree (4) | Slightly Agree (5) | Agree (6) | Strongly Agree (7) |
|---|---|---|---|---|---|---|---|---|
| Cognitive Learning Strategies | Academically successful students | 0 | 0 | 0 | % | 7% | 66% | 27% |
| | Academically average students | 0 | 0 | 0 | 10% | 48% | 35% | 7% |
| | Academically unsuccessful | 0 | 3% | 8% | 14% | 28% | 45% | 0 |
| Metacognitive strategies | Academically successful students | 0 | 0 | 0 | % | 10% | 50% | 40% |
| | Academically average students | 0 | 0 | 0 | 13% | 57% | 42% | % |
| | Academically unsuccessful | 0 | 0 | 8% | 17% | 46% | 30% | 0 |
| Resource management strategies | Academically successful students | 0 | 5% | 15% | 15% | 35% | 15% | 15% |
| | Academically average students | 0 | 0 | 4% | 29% | 49% | 20% | % |
| | Academically unsuccessful | 0 | 2% | 45% | 36% | 33% | 25% | % |

The two tables above show that over 90% of the successful students from both levels of study, scored between 6 and 7 for cognitive and metacognitive learning strategies, indicating responses between “agree” and “strongly agree”. Only 30% gave the same responses for resource management strategies, the other 70% scored between 2 and 5, indicating responses from “disagree” to “slightly agree”.

The tables also show that 42% of the average students scored between 6 and 7 for cognitive and metacognitive learning strategies, indicating responses between “agree” and “strongly agree”. Only 20% of the students in this category gave the same responses for resource management strategies, the other 80% scored between 3 and 5, indicating responses from “slightly disagree” to “slightly agree”.

A smaller percentage of the unsuccessful students (45 and 30%) scored between 6 and 7 for cognitive and metacognitive learning strategies respectively, indicating responses between “agree” and “strongly agree, with only 25% of these students scoring the same for resource management strategies. The other 75% scored between 2 and 5, indicating responses from “disagree” to “slightly agree”.

Overall, the successful students were found to employ cognitive and metacognitive learning strategies more frequently compared to both the academically average and the unsuccessful students at these two levels of study. The use of resource management strategies was found to be low for the majority of the students across all the three levels of study.

## 4.4 Interview Data

In this section a summary of the interview data is presented using a table according to the labelling and grouping of similar responses procedure discussed in the previous chapter, followed by brief comments on the findings.

**Table 4.16**

Summary of interview responses

| Respondents | Interview Question | Common Response |
|---|---|---|
| 1,7,13 (successful students) | 1 | I love science and I chose this subject in high school, so I am continuing with it. |
| | 3 | Yes I have always been good in Maths and science, even in high school |
| | 7 | I like to read my work, then make my own notes and summaries |
| | 9 | Yes I always try to think and make sense of new work |
| | 10 | Good grades mean a good academic record, this pleases my parents and it makes me feel good |
| | 12 | I often use the other information on the internet, tutorials, you tube videos and library books |
| | 11 | I separate and file my work for each module |
| | 13 | Yes I do, I spend a lot of time here on campus studying maths and science |
| 2,3,5,9,10,15, 17,18 (Academically average and un successful) | 13 | No it is difficult, science is not the only module I do and there is not enough time. |
| | 6 | I do not put it away, but I always find myself finishing up close to deadline |
| | 7 | I read and practice examples in my notes, but no I am not doing enough I know, because there is not enough time. |
| 1-6 (Level 1's) | 4 | No, not really, I never do that. (this question came as a surprise to most learners) |
| | 8 | Both work for me |
| | 11 | I use different note books for each module. |
| | 14 | No honestly, I have never heard of it before. |

| Respondents | Interview Question | Common Response |
|---|---|---|
| All respondents | 11 | I separate my work and I use different note books for each module. |
| | 9 | All the respondents said they always try to link new knowledge with prior knowledge. The differences only come with the level of success and perseverance in trying to understand. |
| | 5 | Yes. very much, schools are always short of science teachers. (respondent 1 elaborated and said, one of the things in my mind is to study pharmacy after this course) |
| | 6 | To be honest I now look at the deadlines because of always having a lot of work to do |
| | 7 | All respondents mentioned reading and summarising their notes as part of their learning processes. |
| 1,2,9,13,15 | 7 | I read, practise examples and cram some of the theories before I go to write tests. |
| | 7 | I read my pre-prac the day before I go to the lab. This helps me work faster in the lab. |
| 8,13-18 | 14 | These students tried to explain Srl as the type of learning where the learner has their personal form of system that they use to study and plan their time and activities. |
| 7-11 | 14 | The type of learning that is controlled by each student personally. (These students took some time to think before responding to this question and they did not sound very convincing) |
| 1 | 3 | I do enjoy it, besides getting a lot of money in the future, my mind opens up and thinks broader |
| 2,6,7,8,13 (some of the successful students) | 3 | Yes I enjoy it, the chemistry section mostly because I do well in it. |
| 11,12,17,18 (level 2-3 un successful) | 3, | I used to enjoy studying science in high school, because I used to pass it. Now I always have too much work to do…it stresses me now. |
| 5 and 6 respective responses (level 1 unsuccessful) | 3 | No I am so stressed because, I always try to read my notes and do examples but, when I have to write tests it becomes so difficult and the questions are not like the examples in the notes. |

### 4.4.1 Motivation to study Science

Table 4.16 shows that majority of the academically successful students' responses indicate that these students do believe in their capabilities to succeed, they are motivated by good grades and they enjoy studying science. On the contrary some of the academically unsuccessful students (respondents 11, 12, 17 and 18) expressed a lot of frustration concerning their poor performance. They spoke about always being stressed-out, because of not doing well due to not having enough time to complete tasks, hence are not confident that they can master science knowledge. This indicates an association between grade motivation, self-efficacy and enjoyment, for both the academically successful and the academically unsuccessful students. To further elaborate on this finding, it was noted that respondents 2 and 6 (academically successful and academically unsuccessful, respectively) said the following; "Yes I enjoy science, the chemistry part especially because I get high marks for it" (Respondent no.2 interview, October 22, 2015). "I used to enjoy learning science in high school, because I used to pass it, now I always have too much work to do…it really stresses me out" (Respondent no.6 interview, October 22, 2015).

All the respondents responded "yes" to interview question 5, "will knowing of science give you a career advantage, and if so how?" Over 70 % of the respondents justified their response by stating that the country does not have enough Physical Sciences teachers, hence they will never struggle to find jobs.

### 4.4.2 Learning Strategies to study science

In this section brief comments on findings from the interview responses to the interview questions looking at the learning strategies are given.

**Cognitive learning strategies.**

All respondents mentioned that they read notes, practise and make summary notes as part of their learning. Rehearsal and elaboration strategies could therefore be identified as the main strategies the students rely on for academic success.

**Metacognitive learning strategies.**

All the level 1 interview respondents said that they rarely take time to think about their learning processes, let alone monitoring and evaluating them. Looking at the organisation scale of metacognition, all respondents spoke about filing and separating their work according to different modules.

**Resource management strategies.**

All the interviewed students said that they were aware of the resources at their disposal, like the library and the internet. The successful students said that in addition to lecture notes, they often use the information on the internet, tutorials, You-Tube videos and library books. Two successful students from level 1 and 3 said the following; “I know I will do well because I have so many resources around me and there are many others doing science around me” (Respondent no.2 interview, October 22, 2015). “There are so many things we can use from the internet to study science here on campus and they really help” (Respondent no.14 interview, September 30, 2015).

The academically average and the academically unsuccessful students also said that they make use of the same resources, but once again they stressed the issue of time and working under pressure as the main challenge.

The responses to the last interview question about the Self-regulated learning theory indicate that the theory is foreign to most level 1 and level 2 students. Some of the Level 3 respondents said that they had heard of the concept before. These were some of the definitions they gave, “I know that it is a certain way of learning, the learner has their personal form of system that they use to study and plan his time and way to complete their tasks” (Respondent no.13 interview, September 30, 2015). “I think it is the type of learning that is controlled by each student personally” (Respondent no.17 interview, September 30, 2015).

# CHAPTER 5
# FINDINGS AND DISCUSSION

In the previous chapter, data collected and analysed was presented in the form of tables, Figures, direct quotations and descriptive comments. In this chapter, a discussion of the findings made in light of the reviewed literature to respond to the current study's research questions is given.

The chapter is divided into five sections. In the first three sections the findings in response to each of the three research questions guiding this study are discussed based on the theoretical framework and reviewed literature. In the last two sections a discussion of the validity and reliability of the quantitative findings, followed by the credibility and trustworthiness of the qualitative findings are given.

## 5.1 Motivation to study science

*Research question 1: What motivation profiles do pre- service science teachers have?*

Looking at an overview, the findings of this study suggest that majority of the participants have positive motivation profiles, but at different degrees. It was found that all the academically successful students across the three participating levels of study gave responses indicating positive motivation profiles, where as their fellow academically average and unsuccessful students gave a variety of responses, indicating negative, neutral and positive profiles. The finding of successful students all having positive motivation profiles did not come as a surprise, many researchers of motivation including Areepattamannil, et.al (2010); Muhammed (2010); Bryan, Glynn and Kittleson (2011) also found motivational constructs including intrinsic motivation and self-efficacy to be associated with good academic achievement.

Effeney et al. (2013) found that the more academically capable students were more confident and self-resilient than the less academically capable, meaning that they had more perseverance and they did not give up easily. In the current study the six academically successful interview respondents from the three levels of study when asked what they do when they struggle to understand new

concepts, unanimously responded by saying that they first try again and then exhaust all their options from the internet sources to library books and then go back to the lecturer if all fails. This is evidence of resilience and belief on their individual abilities, that they believe that there must always be a way for them to grasp science knowledge. Furthermore, all these particular students were interviewed at different times, yet they all expressed their excitement at the results of their hard work, evident in their good academic results.

Over 60% of the academically average and poor performing students were also found to have positive motivation profiles, which is surprising as their poor performance may appear not to be linked to low motivation. In the review of literature, no research was found in light of this finding, however in the current study this finding may be explained by interview responses and a minimal use of some of learning strategies (as discussed in the next section). One of the level 1 academically unsuccessful students responded to interview question number 5 about self-efficacy beliefs by saying thus, “I really love Physics and I used to get good marks in high school, but here I am struggling to cram all the work before tests and exams” (Respondent no.6 interview, October 22, 2015).

This response covers both the motivational aspects and learning strategies used to study science, but it will only be discussed to elaborate on the motivation aspects at this point. It indicates that the respondent loves science and that he chose to study it because he believed he could do well, but is now discouraged because he is not doing well and his self-efficacy levels have dropped. Bryan, Glynn and Kittleson (2011) in a similar study of student motivation and achievement found that the student’s intrinsic motivation, self-efficacy, self-determination and performance are related and self-efficacy is the component most related to achievement, which could explain this student’s poor performance and that of other first year students, with similar challenges.

Career motivation was found to be the highest motivating factor for all students (calculated mean responses were all between “often” and “always”). The high scores given by majority of students for career motivation can be attributed to the unemployment challenges faced by this country and the shortage of science teachers. Some Interview respondents touched on the issue often announced in the media that studying science guarantees job security and the country is short of science teachers.

Interview data analysis indicated an association between grade motivation, self-efficacy and enjoyment of learning science for the selected respondents, which was not obvious from the analysis of quantitative data. The more successful students were found to have greater beliefs on their capabilities to do well, were motivated by good grades and they also enjoyed studying science more than the academically unsuccessful students. This is in agreement with research arguments made by Bandura (2001); Middleton and Spanais (2002), these scholars argue that the way in which students interpret their successes or failures has a significant impact on how they perceive their capabilities and hence their self-efficacy and motivation. Bandura (2001, p.10) said, "Efficacy beliefs play a central role in the self-regulation of motivation through goal challenges and outcome expectations. It is partly on the basis of efficacy beliefs that people choose what challenges to undertake, how much effort to extend in the endeavour, how long to persevere in the face of obstacles and failures, and whether failures are motivating or demoralizing". This argument could also be used to explain the frustrations expressed by some of the poor performing students in response to interview question number 3 "*Do you believe that you can master science knowledge and skills?*" Respondent no. 14 responded to this question by saying thus, "No! I am so stressed because, I always try to read my notes and do examples, but when I have to write tests it becomes so difficult and the questions are not like the examples in the notes" (Respondent no.14 interview, September 30, 2015). This response indicates low self-efficacy beliefs due to the level of difficulty experienced and the student's poor academic performance.

McMillan (2010); Bothma and Monteith (2004) also conducted studies on self-regulated learning constructs locally. They found that academically successful students are self-regulated learners, with the most significant constructs of Srl explored being learning strategies and motivation. Their findings on motivation have been confirmed to be true for the successful students participating in the current study. What is surprising is that majority of the academically average and academically unsuccessful students were also found to have positive motivation profiles, as already mentioned before.

When comparing the motivation scores given by the students across all three levels of study, the motivation profile and bar chart showed similar trends across these levels of study. The average scores for all motivation scales showed a decrease as one moves up the levels of study, with intrinsic motivation being the only differing factor (level 3 students scored slightly higher average scores than the level 2 students for this scale). The rest of the other motivation scales followed the same trend of scores between 3 and 4, with career motivation scored the highest motivating factor and self-

determination the least across all three levels of study. These findings were further analysed using the kruskal-Wallis test statistic, a non-parametric statistic used to test for significant differences between the mean scores calculated across the three levels of study. The results obtained showed that there were no significant differences between student motivation profiles from different levels of study ($p > 0.05$), therefore no link between the level of study and motivation was evident. However, the primary purpose for this current study was not to compare student responses across the different levels of study but to give a detailed description of the current situation and give possible explanations behind the findings through interview responses.

To conclude this section on motivation, majority of the pre-service teachers were found to have positive motivation profiles, with career motivation found to be the highest motivating factor and self-determination the least. A positive association between grade motivation, self-efficacy and enjoyment in studying science, was identified and no significant differences between the motivation profiles of students across the different levels of study were found.

A discussion of findings obtained from the learning strategy data analysis is given below to shed more light on the participating students' learning activities.

### 5.2 Learning strategies used to study Science

*Research question 2: What learning strategies do pre-service science teachers use to study science and why?*

Findings made from the analysis of the MSLQ data indicate that all the participants use learning strategies, but at different degrees. It was found that majority (over 75%) of academically successful students use more cognitive learning strategies than the academically average and the academically unsuccessful students. This finding is in agreement with what was found in the review of literature. According to Effeney et al. (2013, p. 68) "The more academically capable participants reported using a wider range of strategies, and more often than the less academically capable participants".

When looking at the use of resource management strategies, low percentage responses were obtained for students across all the academic performance categories from all the three levels of study (+/-30%). This is a cause for concern, considering the fact that these are future teachers, who are expected to go and teach learning strategies to their future students. Part of the academic success of the successful students in this study may only be attributed to the frequent use of the cognitive and metacognitive learning strategies according to the findings of this study. This finding is supported by the findings of Tinajero et al. (2012). These scholars found that cognitive styles combined with other learning strategies significantly contributed to the academic achievement of Brazilian University students. Lebuso (2010) also found this to be true for South African learners.

In a local study to explore learning strategies used by successful high school science learners, Lebuso (2010) found that the successful learners engaged more in self- regulatory activities, and they were influenced in their studies by factors such as family support, the love of the subject and their goals and ambitions. This was also found to be true for the successful students participating in the current study. One of the Level 3 students during the interview spoke about some of his goals and ambitions that motivated him to work hard and to employ various learning strategies. He said thus, “One of the most important things for me that comes to mind is that I have always wanted to do a pharmacy degree, but was never accepted, so I study hard to understand science and get a good academic record because I want to go and study pharmacy when I finish this degree”. (Respondent no.13 interview, September 30, 2015). In addition to the use of learning strategies, this student is also motivated by his goal to pursue further science studies. (This finding also shows possibility of a link between motivation and learning strategy use, an aspect not explored in the current study.)

When looking at the learning strategy use by the average students and the academically unsuccessful students, no significant differences could be identified, from any of the three levels of study. It was found that these students also use cognitive learning strategies, like the successful students (but to a lesser degree), yet they still do not perform well. This may to some degree be explained by the frustrations expressed by the Level 1 academically unsuccessful students interviewed. These students complained that there was always too much work to do and that no matter what they did they never got to cover everything before tests and exams. This can also be attributed to their minimal use of (if any) resource management strategies, leading to them not being able to use their time wisely and only working hard when it is close to tests and exams.

When comparing the learning strategy scores between the three participating levels of study, the learning strategy profile and bar chart showed different trends, indicating a variation in the use of learning strategies by students across the participating levels of study. However, the level 2 students were shown to have the highest scores for the majority of learning strategy scales except for effort regulation and help seeking strategies. The kruskal-Wallis test statistic results however showed that there were no significant differences between learning strategies used by students from the three different levels of study ($p > 0.05$), therefore no links between the level of study and learning strategy use could be shown. The more experienced students were found to rely on the same learning strategies as their less experienced counter parts. This may be an indication that for the participating students, the amount of time spent at the particular university environment does not necessarily mean changes in study habits.

To conclude this section, research findings about cognitive learning strategy use being associated with good academic achievement were proven to be true for the academically successful students. The contrary was observed for majority of their academically unsuccessful counter parts. The percentage distributions obtained for the use of metacognitive learning strategies by the students across the three levels of study, indicated large variations and these are discussed in detail in the next section. Majority of the students participating in this study were found to use more cognitive learning strategies, and very little resource management strategies. This is a serious cause for concern, considering the level of practicality and application of science principles expected to understand science knowledge, which requires a lot more than just rehearsing and memorizing key concepts like most of the participants were found to be doing. More interesting findings about learning strategy use in relation to academic performance are discussed in the section to follow.

### 5.3 Relationships between the Srl constructs of interest and academic achievement

*Research question number 3: Are there any relationships existing between the Self-regulated learning constructs (motivation and learning strategies) and academic achievement?*

The findings from both the SMQ and interviews revealed that the successful students have positive motivation profiles, indicating a positive relationship between Motivation and good academic achievement. This relationship is supported by findings from many research studies including

Areepattamannil, et.al (2010); Muhammed (2010); Bryan, Glynn and Kittleson (2011). What came as a surprise was that some of the academically average and the poor performing students were also found to have positive motivation profiles, of which may indicate an association between motivation and poor academic performance. From the literature reviewed no research was found to shed more light on this observation, except for Areepattamannil, et.al (2010) unique finding, that interest in science had a negative effect on science achievement of college adolescents. No other research was found to support his argument and hence this would not be sufficient for us to conclude a link between positive motivation profiles and poor academic performance, however this may be a possibility to be looked at in the future.

Higher percentage distributions were found for the use of cognitive learning strategies by academically successful students, indicating a more frequent use of these learning strategies compared to the academically average and unsuccessful students. This indicated a positive relationship between more frequent use of cognitive learning strategies and good academic achievement, which is supported by various research studies including Lebuso (2010); Tinajero et al. (2012); Effeney et al. (2013).

Lack of use of resource management strategies was found for all participating students across the three levels of study; i.e only about 30% of the participating students were found to use resource management learning strategies. No explicit conclusions concerning a relationship between the resource management learning strategy construct and academic achievement could be made.

The percentage distributions obtained for the use of metacognitive learning strategies by the students across the three levels of study, indicated wide variations. A larger percentage of level 1 and level 2 academically average students and academically unsuccessful students was found to employ more metacognitive learning strategies than that of the academically successful students at the same levels of study (84%, 58% and 35 % respectively), which is surprising. This indicated a negative relationship between frequent use of metacognitive learning strategies and academic success. In the review of available literature no research was found to support or contradict this finding, it is thus important to highlight the lack of available research on studies that looks at the performance of academically average students. The focus has always been on the academically successful students as well as the academically unsuccessful students.

The opposite was found to be true for the Level 3 students. Table 4.14 shows a decrease in percentage distribution of responses as the level of academic success decreases (90%, 42% and 30% respectively). This indicated a positive relationship between academic success and the use of metacognitive learning strategies for students at this level of study. This finding is supported by the argument made in the theoretical framework section of chapter 2, that students who use metacognitive strategies, regulate, monitor and evaluate their learning activities towards good academic achievement, further supported by empirical studies on this topic by researchers including Eisenberg, (2010); Martinez, (2006); Paris and Winograd, (1990); Ray & Smith, (2010); Schraw et al., (2006).

The findings discussed above indicate contradicting relationships between academic achievement and the use of metacognitive learning strategies. Not much could be drawn from the interview responses given by the 18 selected students on this subject, since majority said that they rarely take time to think about their learning processes, let alone monitoring and evaluating them. As a matter of fact, from observing the reaction on the faces of respondents when asked questions addressing this aspect of learning, the mere fact that they were expected to consciously think about their learning process, monitor and evaluate them came as a shock to them. This could be an indication of a possibility of un-awareness of having such a responsibility, which is another course for concern, considering the fact that these are university students soon to be professionals. These contradicting findings are discussed further in the following section concerning the question of validity and reliability of findings.

To conclude this section, a positive relationship between frequent use of cognitive learning strategies and good academic achievement was identified. No relationship between motivation and good or bad academic achievement could be clearly identified because positive motivation profiles were found for all student categories (high achievers, average achievers and under achievers). This finding could not be explained using the available literature and can thus be recommended for future research.

### 5.4 Validity and Reliability of quantitative data findings

The measures taken to ensure validity and reliability of quantitative results obtained were presented in the previous chapter. In addition to the quantitative research instruments having their validity already been well established, internal checks were performed and strict sorting of raw data was done to eliminate all the questionnaires with considerably invalid responses as explained through the use of examples in the presentation of findings. Possible limitations that this could pose to the findings made in this study are acknowledged, however valid findings were prioritised over having large volumes of data, which could comprise the validity and reliability of the very same study's findings.

Some contradicting findings were identified. For example, the contradicting relationships existing between academic achievement and the use of metacognitive learning strategies by students from different levels of study as discussed in section 5.3. Since not much could be drawn from the interview responses and no literature was found to elaborate on such findings, one other option would be to question the validity of some of the findings made. However, the fact that majority of the students were found not to be even acquainted with the term "metacognitive" learning strategies opens room for even more possibilities to explain the contradictions.

### 5.5 Credibility, trustworthiness and dependability of qualitative data findings

In the previous chapter the need for addressing issues of rigor from two different viewpoints (quantitative and the qualitative) as well as the differences in terminology used were discussed, hence the use of the terms credibility, trustworthiness and dependability in this section. The responses obtained can be considered credible, trustworthy and dependable, because of the necessary measures taken to ensure this as also discussed in the previous chapter.

Based on the criteria used to select interviewees, the sample of 18 interview respondents was considered a good representative of the population of participating pre-service teachers. Even though most possibilities of bias were eliminated during data collection, one cannot ascertain this to be entirely

the case for data analysis, however attention was given to both the expected (as according to the reviewed literature) and the surprising findings made.

The qualitative data analysis findings obtained through the interviews support the quantitative data analysis findings made concerning the student motivation profiles and those concerning the use of cognitive learning strategies. This shows a good collaboration between the two methods of data collection employed, in response to the research questions of this study. However, there were some findings which could not be explained within the scope of this study, for example; the inconsistencies found in the use of metacognitive learning strategies and resource management strategies by students with different academic performances.

To conclude this section, the design of this mixed methods study was a typology based sequential design, where two research methods were employed sequentially with an aim to produce an indepth case. This was not done for comparison or validation purposes, hence triangulation of research methods as one of the powerful tools used in mixed methods research to strengthen the validity and reliability of findings was not utilised. However, the necessary procedures as discussed before were followed to ensure that the data collected and the findings made can be considered reliable, valid, and credible for the particular case of interest and cannot be generalised to other contexts.

# CHAPTER 6
# SUMMARY, IMPLICATIONS AND CONCLUSIONS

## 6.1 Summary of findings

The purpose of this study was to explore the pre-service teachers' motivation to major in Physical Science education specialisation, the learning strategies they use, and the impact these have on their academic achievement. To achieve this, a case of university pre-service teachers, consisting of three further internal cases was studied, using a mixed methods approach. To summarise the findings of this study for ease of understanding and coherence, a matrix was used as illustrated below.

**Table 6.1**

Summary of findings from the two research approaches adopted sequentially

| Research Question | Quantitative Data results (Method 1) | Qualitative Data results (Method 2) | Results of Methods (Methods 1 + 2) |
|---|---|---|---|
| 1. What motivation profiles do pre- service science teachers have? | * Majority of participants have positive motivation profiles.<br><br>* Career motivation was scored the highest motivation factor, with Self-determination scored the least.<br><br>* Student levels of motivation were found to decrease when moving up the three participating levels of study. | *Majority of interviewed respondents were found to have positive motivation profiles<br><br>* A positive association between grade motivation (GM), self-efficacy (SE) and enjoyment experienced in studying science was observed (in that order).<br><br>*The issue of not having enough time to attend to all learning activities was highlighted as the main challenge, possibly leading to low levels of self- efficacy for some of the academically unsuccessful students.<br><br>*Majority of the interviewed respondents highlighted the fact that the country has a shortage of Physical Sciences teachers, hence job security for science teachers is guaranteed. | * Majority of the pre-service teachers were found to have positive motivation profiles, with career motivation found to be the highest motivating factor and self-determination the least.<br><br>* A positive association between grade motivation, self-efficacy and enjoyment in studying science, was identified. |

| Research Question | Quantitative Data results (Method 1) | Qualitative Data results (Method 2) | Results of Methods (Methods 1 + 2) |
|---|---|---|---|
| 2. What learning strategies do they use to study Physical Sciences and why? | *Majority of the participants rely on cognitive learning strategies, with the academically successful employing these strategies more frequently, compared to their counter parts.<br><br>* It was surprising to find that majority of the students relied more on rehearsing and memorizing key words, seeing science is more of a practical subject with a lot of calculations used to explain phenomena.<br><br>* Minimal use of metacognitive and resource management strategies by students across all three levels of study, was found. | * Cognitive learning strategies were found to be the most commonly used learning strategies.<br><br>* The respondents were found to be aware of the resources at their disposal and can use them, whether the use was managed appropriately remains questionable.<br><br>* The academically average and the academically unsuccessful students said that they make use of available resources, such as the You-tube videos and library books but stressed the issue of time and working under pressure as the main hindrance for them taking full advantage. | *The pre-service teachers were found to employ more cognitive learning strategies, than the other two learning strategies tested.<br><br>*The fact that these students relied on strategies like rehearsing, memorising and cramming came as a surprise, considering the nature and expectations of gaining Physical Sciences knowledge. |
| 3. Are there any relationships between the Srl constructs (motivation and learning strategies) and academic achievement? | * A positive relationship was found to exist between positive motivation profiles and academic achievement of academically successful students, as claimed by research. However, majority of the academically unsuccessful students were also found to have positive motivation profiles.<br><br>*Frequent use of cognitive learning strategies was found to be associated with good academic achievement as also claimed by research. | * A relationship between Self-efficacy and academic achievement was found.<br><br>*The relationship between frequent use of cognitive learning strategies by the academically successful students with good academic achievement was confirmed. | The following positive relationships were Identified:<br><br>* Positive motivation profiles and good academic achievement.<br><br>* Positive motivation profiles and poor academic performance.<br><br>*Frequent use of cognitive learning strategies and good academic achievement. |

In table 6.1, a detailed summary of findings in response to this study's research questions was given. These and other findings made in this study concerning the participants' motivation and learning activities are further summarised below.

Positive motivation profiles and frequent use of learning strategies were both found to be associated with good academic achievement, particularly for students categorised as academically successful, as predicted by research. The academically average and academically unsuccessful students were found to have a variety of motivation profiles (negative, neutral and positive motivation profiles). However, a significant number (over 50%) of academically unsuccessful students were also found to have positive motivation profiles. They also indicated use of cognitive learning strategies (though to a lesser degree), yet were still academically unsuccessful. To elaborate on the possible reasons behind this, interviewed students emphasised the issue of the immense pressure they always found themselves working under. They argued that there was always too much work to do and they never had enough time to complete all the tasks given to them.

Majority of the students participating in this study were found to rely on rehearsal learning strategies, but not so much on metacognitive and resource management strategies. This is surprising considering the level of practicality and expected application of science principles to explain phenomena. This surely requires a lot more than just rehearsing and memorizing key concepts.

Contradicting relationships between academic achievement and use of metacognitive learning strategies were found to exist in the case of participating university pre-service teachers. This finding could not be elaborated on using the interview data because no conscious or intentional use of these strategies was observed for any of the interviewed respondents. Majority of the students said they rarely take some time to think about their learning processes, let alone monitoring and evaluating them. In fact the interview questions addressing this aspect of learning actually came as a shock to most students, indicating a possibility of un-awareness of this particular learning strategy, which is a course for concern.

The academically successful students, academically average students and the academically unsuccessful students' responses indicated a lack of use of resource management strategies across all three levels of study. This is another course for concern and no relationships between the resource management learning strategy construct and academic achievement could thus be identified.

The Kruskal-Wallis hypothesis test results showed that there were neither significant differences ($p > 0.05$) between student motivation profiles nor between learning strategies used by students due to their level of study.

Identified causes for concern:

Minimal use of metacognitive and resource management strategies by students across the three levels of study; Lack of awareness of the Self-regulated learning theory and the responsibility the students have to use metacognitive learning strategies, which include thinking about their learning, planning, monitoring and evaluating their learning processes.

### 6.2 Study Limitations

This study only looked at the student's performance for one module over one semester not at the students' overall performance over the years, there is thus a possibility of having the term marks used to make conclusions in this study not being a true reflection of the students' overall performance. However, if that is the case it is important to take into consideration the fact that the motivation profiles and learning strategies used by individual students could have been changing with the different modules they took over the years, hence the findings of this study are specific to only the context explored and similar contexts but cannot be generalized.

No significant differences in motivation profiles and learning strategies used by academically average and the academically unsuccessful students could be identified. This study was therefore not able to explain the reasons behind performance differences between the two types of student categories.

Srl is a complex theory with many constructs as discussed in chapter 2, so a lot of research has been done on the subject, but most of it is general and it is challenging to find literature that is only specific to motivation and learning strategies as the main constructs. Because of this, the study had to draw a lot from older studies and with the constructs of interest being complex and consisting of further components of their own, a lot of extraction and collaboration needed to be done. It was also necessary

for me to rely on the same articles for different aspects of the review, hence some of the articles are made reference to more than three times in the literature review chapter as well as in the discussion chapter.

Most of the available research on learning strategies is older than 10 years, some of it may still be relevant today but more current studies are required, especially with the vast advancements in technology, introducing a variety of reasons to study science using different tools. The biggest concern lies with the lack of local research on resource management strategies, hence reliance on research conducted in the first world countries as these countries advance at a much faster pace than the third world African countries, which we are part of.

### 6.3 Implications to instruction

Some of the findings of this study are in agreement with the findings of other research studies concerning the positive relationships found to exist between motivation and academic success as well as between frequent use of cognitive learning strategies and academic success. These relationships were found to be evident in the responses given by the students categorised as academically successful, indicating that having positive motivation profiles and frequent use of cognitive learning strategies may be instrumental in their academic success. It is thus recommended for University policy makers to prioritise motivation to learn and learning strategies used to do so, as influencers of academic success and content knowledge attainment.

This can be done through introducing learning strategy instruction programs. According to Gamze, Mehmet & Kamile (2009) learning strategy instruction influences students' performance on problem solving and asking strategic questions, their ability to remember more content, their retention and comprehension level. This intern leads to increased levels of self-efficacy and self-determination and hence motivation. Mcmillan (2010) also found similar to be true for South African school learners. This will benefit both the students and the universities in producing academically successful teachers who are motivated and with good teaching and learning practices.

Conducting this study also assisted in identifying some of the critical problem areas, for example in this study it was found that majority of student teachers lack resource management strategies, hence they always find themselves being overwhelmed with too much work to do within a limited space of time. This leads to the use of learning strategies that produces superficial conceptual understanding, like cramming and less time "if any" can be spent applying metacognitive learning strategies like thinking about one's learning processes, planning, reviewing and adapting whenever necessary. The second implication from the findings of this study therefore concerns the conducting of regular assessments of student motivation profiles and learning strategies to study science. This is highly recommended and not only through the use of surveys as these may at times only help in identifying the problems, but also through interviewing selected students. Interviews provide for probing, which helps to identify causal effects and further challenges that the students might be experiencing.

Overally, there are two implications that can be made from the findings of this study. Firstly, the University policy makers are to prioritise motivation to learn and learning strategies used to do so, as influencers of academic success and content knowledge attainment. This can be achieved through introducing learning strategy instruction programs. Secondly, conducting of regular student motivation and learning strategy assessments, through using both surveys and interviews to identify learning problems and challenges experienced by the students.

### 6.4 Conclusion

The aim of this study to explore the pre-service teachers' motivation and learning strategies used to study science, and the impact these have on academic achievement was met. Most of the findings obtained concur with what has been found by scholars locally and internationally, that motivation to study science and appropriate learning strategy use have a positive impact on the academic success of science students. There were a few surprises when it comes to motivation constructs not only being associated with academically successful students, but with the less successful students too. This highlights the importance of exploring motivation constructs together with the appropriate use of Srl strategies, that it is not only one factor that predicts academic success but a combination of various factors. Majority of the participating students were found to lack metacognitive and resource management strategies, this is a great cause for concern and possibly one of the main reasons behind the problem of superficial conceptual understanding and poor academic performance in South Africa. It

is important to emphasize the fact there there will always be a lot of activities for individual students to attend to and if one cannot plan their activities, monitor and manage their resources well, they will struggle to succeed. Universities therefore need to invest in programs that will develop students in this regard.

### 6.5 Lessons learnt and recommendations for future research

In the process of conducting this study as well as from personal experience, I have come to realise that in science communities; good grades, career growth, new technologies and inventions are central topics most talked about and given credit to, yet locally there were no empirical studies found to have explicitly investigated these as extrinsic motivators to study science. This is an interesting area recommended for future research.

Learning strategy instruction in South African and its contribution to academic performance is another area of interest with minimal available research literature recommended for future research.

Another recommended area of interest is that of resource management strategies. These were found to be crucial learning strategies necessary for university students to cope with the everyday distractions and to use their time and resources purposefully to enhance academic performance, yet it was also found that there is minimal literature available in this area both locally and internationally (Banarjee and Kumar (2014).

Lastly, the more experienced students were found to rely on the same learning strategies as their less experienced counter parts, indicating that the amount of time the students spent in this university environment did not necessarily mean changes in study habits, which is rather surprising and can be recommended as a topic of interest for future research.

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# APPENDICIES

# APPENDIX A QUESTIONNAIRES

## SCIENCE MOTIVATION QUESTIONNAIRE II (SMQ II)

Name _____ Module _____

Year of study_____ Home language _____

Gender: M / F

Age_____

- *No one is obliged to participate and you can withdraw your cooperation at any stage. Participation is voluntary.*
- *At no stage of the research will your name be disclosed or published by anyone or in any report. This project is purely for research into student learning.*
- *Completing the questionnaire will not result in you gaining any marks toward your module nor there any other material advantage for those who participate nor any disadvantage for those who choose not to participate.*

INSTRUCTIONS: Respond to the statements by circling the number that best describes your feelings about this course

**RESPONSE SCALE**
**NEVER ALWAYS** ⟹

| | **STATEMENTS ABOUT LEARNING IN THIS MODULE** | **Never** | **Rarely** | **Sometimes** | **Usually** | **Always** |
|---|---|---|---|---|---|---|
| 1 | The Science I learn is relevant to my life | | | | | |
| | I like to do better than other students on science tests | | | | | |
| | Learning Science is interesting | | | | | |
| | Getting a good science grade is important to me | | | | | |
| | I put enough effort into learning science | | | | | |
| | I use strategies to learn science well | | | | | |
| | Learning Science will help me get e good job | | | | | |
| | It is important that I get an “A” in science | | | | | |
| | I am confident I will do well on science tests | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | Knowing science will give me a career advantage | | | | | |
| 1 | I spend a lot of time learning science | | | | | |
| 2 | Learning science makes my life more meaningful | | | | | |
| 3 | Understanding science will benefit me in my career | | | | | |
| 4 | I am confident I will do well on science labs and projects | | | | | |
| 5 | I believe I can master science knowledge and skills | | | | | |
| 6 | I prepare well for science tests and labs | | | | | |
| 7 | I am curious about discoveries in science | | | | | |
| 8 | I believe I can earn a grade of “A” in science | | | | | |
| 9 | I enjoy learning science | | | | | |
| 0 | I think about the grade I will get in science | | | | | |
| 1 | I am sure I can understand science | | | | | |
| 2 | I study hard to learn science | | | | | |
| 3 | My career will involve science | | | | | |
| 4 | Scoring high on science tests and labs matters | | | | | |
| 5 | I will use science problem-solving skills in my career | | | | | |

**THANK YOU**

**Motivation Scales and their respective items**

| Scale | Items |
|---|---|
| Intrinsic Motivation | 1,3,12,17,19 |
| Career Motivation | 7,10,13,23,25 |
| Self determination | 5,6,11,16,22 |
| Self-efficacy | 9,14,15,18,21 |
| Grade Motivation | 4,8,20,24,18 |

## MOTIVATED LEARNING STRATEGY QUESTIONNAIRE (MSLQ) PART 2

Name _____ Module

_____

Year of study _____ Home language

_____

Gender: M / F

Age_____

- *No one is obliged to participate and you can withdraw your cooperation at any stage. Participation is voluntary.*
- *At no stage of the research will your name be disclosed or published by anyone or in any report. This project is purely for research into student learning.*
- *Completing the questionnaire will not result in you gaining any marks in this module, nor will there be any other material advantage for those who participate nor any disadvantage for those who choose not to participate.*

INSTRUCTIONS: Respond to the statements by circling the number indicating your agreement or disagreement.

**LEVEL OF AGREEMENT**

**Disagree** **Agree** →

| | **STATEMENTS ABOUT LEARNING IN THIS MODULE** | **Strongly DISAGREE** | **Disagree** | **Slightly Disagree** | **Neither agree or disagree** | **Slightly Agree** | **Agree** | **Strongly AGREE** |
|---|---|---|---|---|---|---|---|---|
| | When I study the readings for this module, I outline the material to help me organize my thoughts. | | | | | | | |
| | During class time I often miss important points because I'm thinking of other things. | | | | | | | |
| | When studying for this module, I often try to explain the material to a classmate or friend. | | | | | | | |
| | I usually study in a place where I can concentrate on my work. | | | | | | | |
| | When studying for this module, I make up questions to help me learn. | | | | | | | |
| | I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do. | | | | | | | |
| | I often find myself questioning things I hear or read in this module to decide if I find them convincing. | | | | | | | |
| | When I study for this class, I practice saying the material to myself over and over. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone. | | | | | | | |
| 0 | When I become confused about something I'm studying for this module, I go back and try to FIGUREit out. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | When I study for this module, I go through my class notes and try to find the most important ideas. | | | | | | | |
| 2 | I make good use of my study time for this module. | | | | | | | |
| 3 | If readings or notes are difficult to understand, I change the way I read the material. | | | | | | | |
| 4 | I try to work with other students from this class to complete tasks. | | | | | | | |
| 5 | When studying for this module, I read my class notes and the course readings over and over again. | | | | | | | |
| 6 | When a theory, interpretation, or conclusion is presented in class or in the notes, I try to decide if there is good supporting evidence. | | | | | | | |
| 7 | I work hard to do well in this class even if I don't like what we are doing. | | | | | | | |
| 8 | I make simple charts, diagrams, or tables to help me organize module material. | | | | | | | |
| 9 | When studying for this module, I often set aside time to discuss module material with a group of learners from the class. | | | | | | | |
| 0 | I treat the module material as a starting point and try to develop my own ideas about it. | | | | | | | |
| 1 | I find it hard to stick to a study timetable. | | | | | | | |
| 2 | When I study for this class, I pull together information from different sources, such as lessons, notes and discussions. | | | | | | | |
| 3 | Before I study new module material thoroughly, I often skim it to see how it is organized. | | | | | | | |
| 4 | I ask myself questions to make sure I understand the material I have been studying in this class. | | | | | | | |
| 5 | I try to change the way I study in order to fit the module requirements and the teacher's teaching style. | | | | | | | |
| 6 | I often find that I have been reading for this module, but don't know what it was all about. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7 | I ask the lecturer to clarify concepts I don't understand well. | | | | | | | |
| 8 | I memorize key words to remind me of important concepts in this class. | | | | | | | |
| 9 | When work is difficult, I either give up or only study the easy parts. | | | | | | | |
| 0 | I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this module. | | | | | | | |
| 1 | I try to relate ideas in this module to those in other modules whenever possible. | | | | | | | |
| 2 | When I study for this module, I go over my class notes and make an outline of important concepts. | | | | | | | |
| 3 | When reading for this module, I try to relate the material to what I already know. | | | | | | | |
| 4 | I have a regular place set aside for studying. | | | | | | | |
| 5 | I try to play around with ideas of my own related to what I am learning in this module. | | | | | | | |
| 6 | When I study for this module, I write brief summaries of the main ideas from the readings and my class notes. | | | | | | | |
| 7 | When I can't understand the material in this module, I ask other students in this class for help. | | | | | | | |
| 8 | I try to understand the material in this class by making connections between the notes and the concepts covered in class. | | | | | | | |
| 9 | I make sure that I keep up with the homework given to me in this module. | | | | | | | |
| 0 | Whenever I read or hear a statement or conclusion in this class, I think about possible alternatives. | | | | | | | |
| 1 | I make lists of important items for this module and memorize the lists. | | | | | | | |
| 2 | I look forward to my science classes. | | | | | | | |
| 3 | Even when course materials are dull and uninteresting, I manage to keep working until I finish. | | | | | | | |
| 4 | I try to identify students in this class whom I can ask for help if necessary. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | When studying for this module I try to determine which concepts I don't understand well. | | | | | | | |
| 6 | I often find that I don't spend very much time on this module because of other activities. | | | | | | | |
| 7 | When I study for this class, I set goals for myself in order to direct my activities in each study period. | | | | | | | |
| 8 | If I get confused taking notes in class, I make sure I sort it out afterwards. | | | | | | | |
| 9 | I have little time to review my notes or readings before an exam. | | | | | | | |
| 0 | When I study, I try to apply ideas from notes and class discussions. | | | | | | | |

**Learning strategy Scales and their respective items**

| Scale | Items |
|---|---|
| Rehearsal | 8,15,28,41 |
| Elaboration | 22,31,33,36,38,38,50 |
| Organization | 1,11,18,32 |
| Critical Thinking | 7,16,20,32,40 |
| Metacognitive Self-regulation | 2,5,10,13,23,24,25,26,30,45,47,48 |
| Time and Study Environment | 4,12,21,34,39,42,46,49 |
| Effort Regulation | 6,17,29,43 |
| Peer Learning | 3,14,19 |
| Help Seeking | 9,27,37,44 |

# APPENDIX B INTERVIEW SCHEDULE

**Q1:** Why did you choose the science discipline amongst the others?

**Q2:** Do you enjoy studying science, and what value does it add to your life?

**Q3:** Do you believe you can master Science knowledge and skills?

**Q4:** Do you ever take time to think about your thinking and learning?

**Q5:** Will knowing of Science give you a career advantage, and if so, how?

**Q6:** Would you describe yourself as the consistent hardworking type or you always put away school work and finish it up close to the deadline?

**Q7:** How do you prepare for tests and labs, do you think you are doing enough?

**Q8**: Do you prefer studying in a group or individually?

**Q9:** When new knowledge is presented to you, do you critically ask yourself if it is sensible and link it with prior knowledge, or you just take it as it is and work towards understanding it?

**Q10:** What does getting good grades mean to you?

**Q11:** How do you organize your work?

**Q12:** Do you use other sources of information in addition to the notes you get in class and prescribed text books?

**Q13:** Do you often feel that you put enough time and effort in your studying Science?

**Q14:** What is your understanding of the theory of Self-regulated learning?

## THANK YOU

# APPENDIX C PERCENTAGE (%) DISTRIBUTION AND CORRELATION TABLES

**Table C1**

% distribution of level 1 students' responses to SMQ (II)

| Scale | | Never | Rarely | Sometimes | Usually | Always |
|---|---|---|---|---|---|---|
| Intrinsic Motivation | Academically successful students( n = 17) | 0 | 0 | 0 | 60% | 40% |
| | Academically average students (n=21) | 0 | 0 | 9% | 50% | 41% |
| | Academically unsuccessful students (n=9) | 0 | 0 | 11% | 46% | 33% |
| Career Motivation | Academically successful students | 0 | 0 | 0 | 20% | 80% |
| | Academically average students | 0 | 0 | 0 | 27% | 73% |
| | Academically unsuccessful students | 0 | 0 | 0 | 11% | 89% |
| Self-determination | Academically successful students | 0 | 0 | 0 | 40% | 60% |
| | Academically average students | 0 | 0 | 23% | 41% | 36% |
| | Academically unsuccessful students | 0 | 0 | 22% | 56% | 22% |
| Self-efficacy | Academically successful students | 0 | 0 | 0 | 40% | 60% |
| | Academically average students | 0 | 5% | 5% | 54% | 36% |
| | Academically unsuccessful students | 0 | 0 | 0 | 67% | 33% |
| Grade Motivation | Academically successful students | 0 | 0 | 0 | 40% | 60% |
| | Academically average students | 0 | 0 | 10% | 36% | 54% |
| | Academically unsuccessful students | 0 | 0 | 0 | 56% | 44% |

**Table C2**

% distribution of level 2 students' responses to SMQ (II)

| Scale | | Never | Rarely | Sometimes | Usually | Always |
|---|---|---|---|---|---|---|
| Intrinsic Motivation | Academically successful students (n=3) | 0 | 0 | 0 | 50% | 50% |
| | Academically average students (n=13) | 0 | 0 | 0 | 64% | 36% |
| | Academically unsuccessful students (n=9) | 0 | 0 | 50% | 20% | 30% |
| Career Motivation | Academically successful students | 0 | 0 | 0 | 75% | 25% |
| | Academically average students | 0 | 0 | 0 | 36% | 64% |
| | Academically unsuccessful students | 0 | | 10% | 10% | 80% |
| Self-determination | Academically successful students | 0 | 0 | 0 | 75% | 25% |
| | Academically average students | 0 | 0 | 9% | 73% | 18% |
| | Academically unsuccessful students | 0 | 0 | 40% | 50% | 10% |
| Self-efficacy | Academically successful students | 0 | 0 | 0 | 75% | 25% |
| | Academically average students | 0 | 0 | 0 | 73% | 27% |
| | Academically unsuccessful students | 0 | 0 | 30% | 50% | 20% |
| Grade motivation | Academically successful students | 0 | 0 | 0 | 25% | 75% |
| | Academically average students | 0 | 0 | 0 | 45% | 55% |
| | Academically unsuccessful students | 0 | 0 | 30% | 30% | 40% |

**Table C3**

% distribution of level 3 students' responses to SMQ (II)

| Scale | | Never | Rarely | Sometimes | Usually | Always |
|---|---|---|---|---|---|---|
| Intrinsic Motivation | Academically successful students (n=5) | 0 | 0 | 0 | 60% | 40% |
| | Academically average students (n=17) | 0 | 0 | 18% | 53% | 29% |
| | Academically unsuccessful students (n=11) | 0 | 0 | 18% | 73% | 9% |
| Career Motivation | Academically successful students | 0 | 0 | 0 | 20% | 80% |
| | Academically average students | 0 | 0 | 5% | 35% | 65% |
| | Academically unsuccessfulstudents | 0 | 0 | 0 | 45% | 55% |
| Self-determination | Academically successful students | 0 | 0 | % | 40% | 60% |
| | Academically average students | 6% | 0 | 12% | 58% | 24% |
| | Academically unsuccessful students | 0 | 9% | 27% | 55% | 9% |
| Self-efficacy | Academically successful students | 0 | 0 | 0 | 40% | 60% |
| | Academically average students | 0 | 0 | 12% | 59% | 27% |
| | Academically unsuccessful students | 0 | 0 | 55% | 45% | 0 |
| Grade Motivation | Academically successful students | 0 | 0 | 0 | 40% | 60% |
| | Academically average students | 0 | 0 | 12% | 76% | 12% |
| | Academically unsuccessful students | 0 | 9% | 28% | 45% | 18% |

**Table C4**

% distribution of level 1 students' responses to MSLQ

| Scale | | Strongly Disagree (1) | Disagree (2) | Slightly Disagree (3) | Neither agree / disagree (4) | Slightly Agree (5) | Agree (6) | Strongly Agree (7) |
|---|---|---|---|---|---|---|---|---|
| Rehearsal | Academically successful students (n = 17) | 0 | 0 | 0 | 0 | 17% | 71% | 12% |
| | Academically average students (n=21) | 0 | 0 | 0 | 18% | 41% | 41% | 0 |
| | Academically unsuccessful students (n=9) | 0 | 0 | 0 | 30% | 20% | 40% | 10% |
| Elaboration | Academically successful students | 0 | 0 | 0 | 0 | 35% | 59% | 6% |
| | Academically average students | 0 | 0 | 5% | 9% | 36% | 45% | 5% |
| | Academically unsuccessful students | 0 | 0 | 0 | 20% | 30% | 40% | 10% |
| Organisation | Academically successful students | 0 | 0 | 6% | 6% | 12% | 53% | 23% |
| | Academically average students | 0 | 0 | 5% | 9% | 32% | 45% | 9% |
| | Academically unsuccessful students | 0 | 0 | 0 | 10% | 40% | 50% | 0 |
| Critical Thinking | Academically successful students | 0 | 0 | 0 | 6% | 47% | 47% | 0 |
| | Academically average students | 0 | 0 | 5% | 9% | 32% | 45% | 9% |
| | Academically unsuccessful students | 0 | 0 | 0 | 20% | 10% | 60% | 10% |
| Metacognitive self-regulation | Academically successful students | 0 | 0 | 0 | 12% | 53% | 35% | 0 |
| | Academically average students | 0 | 0 | 0 | 5% | 50% | 45% | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Academically unsuccessful students | 0 | 0 | 0 | 10% | 50% | 40% | 0 |
| Time and Study environment | Academically successful students | 0 | 0 | 0 | 29% | 53% | 18% | 0 |
| | Academically average students | 0 | 0 | 5% | 45% | 36% | 14% | 0 |
| | Academically unsuccessful students | 0 | 0 | 0 | 50% | 30% | 20% | 0 |
| Effort Regulation | Academically successful students | 0 | 0 | 0 | 35% | 24% | 29% | 12% |
| | Academically average students | 0 | 0 | 0 | 41% | 36% | 18% | 5% |
| | Academically unsuccessful students | 0 | 0 | 0 | 40% | 50% | 0 | 10% |
| Peer Learning | Academically successful students | 0 | 0 | 12% | 12% | 29% | 47% | 0 |
| | Academically average students | 0 | 0 | 0 | 9% | 41% | 45% | 5% |
| | Academically unsuccessful students | 0 | 10% | 0 | 20% | 30% | 40% | 0 |
| Help Seeking | Academically successful students | 0 | 0 | 12% | 29% | 41% | 18% | 0 |
| | Academically average students | 0 | 0 | 14 | 27% | 27% | 32% | 0 |
| | Academically unsuccessful students | 0 | 0 | 0 | 30% | 10% | 60% | 0 |

**Table C5**

% distribution of level 2 students' responses to MSLQ

| Scale | | Strongly Disagree (1) | Disagree (2) | Slightly Disagree (3) | Neither agree / disagree (4) | Slightly Agree (5) | Agree (6) | Strongly Agree (7) |
|---|---|---|---|---|---|---|---|---|
| Rehearsal | Academically successful students (n=3) | 0 | 0 | 0 | 0 | 33% | 0 | 67% |
| | Academically average students (n=13) | 0 | 0 | 0 | | 100% | 0 | 0 |
| | Academically unsuccessful students (n=9) | 0 | 0 | 0 | 17% | 0 | 67% | 16% |
| Elaboration | Academically successful students | 0 | 0 | 0 | 0 | 0 | 33% | 67% |
| | Academically average students | 0 | 0 | 0 | 0 | 0 | 67% | 33% |
| | Academically unsuccessful students | 0 | 0 | 0 | 17% | 16% | 67% | 0 |
| Organisation | Academically successful students | 0 | 0 | 0 | 0 | 0 | 33% | 67% |
| | Academically average students | 0 | 0 | 0 | 0 | 33% | 33% | 33% |
| | Academically unsuccessful students | 0 | 0 | 0 | 17% | 67% | 16% | 0 |
| Critical Thinking | Academically successful students | 0 | 0 | 0 | 33.3% | 33.3% | 33.3% | 0 |
| | Academically average students | 0 | 0 | 0 | 0 | 33% | 33% | 33% |
| | Academically unsuccessful students | 0 | 0 | 0 | 0 | 34% | 66% | 0 |
| | Academically successful students | 0 | 0 | 0 | 33% | 0 | 67% | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Metacogniti ve self-regulation | Academically average students | 0 | 0 | 0 | 0 | 0 | 100% | 0 |
| | Academically unsuccessful students | 0 | 0 | 0 | 0 | 50% | 50% | 0 |
| Time and Study environmen t | Academically successful students | 0 | 0 | 0 | 0 | 67% | 33% | 0 |
| | Academically average students | 0 | 0 | 0 | 0 | 100% | 0 | 0 |
| | Academically unsuccessful students | 0 | 0 | 0 | 34% | 50% | 16% | 0 |
| Effort Regulation | Academically successful students | 0 | 0 | 0 | 33% | 0 | 33% | 33% |
| | Academically average students | 0 | 0 | 0 | 0 | 33% | 67% | % |
| | Academically unsuccessful students | 0 | 0 | 0 | 50% | 50% | 0 | 0 |
| Peer Learning | Academically successful students | 0 | 0 | 33% | 0 | 33% | 33% | 0 |
| | Academically average students | 0 | 0 | 0 | 0 | 67% | 33% | 0 |
| | Academically unsuccessful students | 0 | 16% | 0 | 0 | 34% | 34% | 16% |
| Help Seeking | Academically successful students | 0 | 0 | 0 | % | 67% | 33% | 0 |
| | Academically average students | 0 | 0 | 0 | 33% | 0 | 67% | 0 |
| | Academically unsuccessful students | 17% | 0 | 0 | 17% | 50% | 0 | 16% |

**Table C6**

% distribution of level 3 students' responses to MSLQ

| Component | | Strongly Disagree (1) | Disagree (2) | Slightly Disagree (3) | Neither agree / disagree (4) | Slightly Agree (5) | Agree (6) | Strongly Agree (7) |
|---|---|---|---|---|---|---|---|---|
| Rehearsal | Academically successful students (n=5) | 0 | 0 | 0 | 0 | 20% | 60% | 20% |
| | Academically average students(n=17) | 0 | 0 | 0 | 0 | 36% | 43% | 14% |
| | Academically unsuccessful students (n=11) | 0 | 9% | 8% | 8% | 33% | 42% | 0 |
| Elaboration | Academically successful students | 0 | 0 | 0 | 0 | 0 | 80% | 20% |
| | Academically average students | 0 | 0 | 0 | 14% | 36% | 42% | 8% |
| | Academically unsuccessful students | 0 | 0 | 8% | 17% | 25% | 42% | 8% |
| Organisation | Academically successful students | 0 | 0 | 0 | 20% | 60% | 250% | 0 |
| | Academically average students | 0 | 0 | 0 | 8% | 71% | 21% | 0 |
| | Academically unsuccessful students | 0 | 0 | 8% | 17% | 25% | 50% | 0 |
| Critical Thinking | Academically successful students | 0 | 0 | 0 | 20% | 60% | 20% | 0 |
| | Academically average students | 0 | 0 | 0 | 15% | 43% | 42% | 0 |
| | Academically unsuccessful students | 0 | 0 | 17% | 8% | 33% | 42% | 0 |
| | Academically successful students | 0 | 0 | 0 | 0 | 40% | 60% | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Metacognitive self-regulation | Academically average students | 0 | 0 | 0 | 8% | 71% | 21% | 0 |
| | Academically unsuccessful students | 0 | 0 | 8% | 17% | 58% | 17% | 0 |
| Time and Study environment | Academically successful students | 0 | 0 | 0 | 20% | 60% | 0 | 20% |
| | Academically average students | 0 | 0 | 15% | 21% | 43% | 21% | 0 |
| | Academically unsuccessful students | 0 | 0 | 0 | 50% | 42% | 8% | 0 |
| Effort Regulation | Academically successful students | 0 | 0 | 0 | 20% | 0 | 40% | 40% |
| | Academically average students | 0 | 0 | 0 | 43% | 50% | 7% | 0 |
| | Academically unsuccessful students | 0 | 0 | 0 | 42% | 16% | 42% | 0 |
| Peer Learning | Academically successful students | 0 | 20% | 40% | 0 | 20% | 20% | 0 |
| | Academically average students | 0 | 0 | 0 | 43% | 50% | 7% | 0 |
| | Academically unsuccessful students | 0 | 9% | 0 | 33% | 25% | 33% | 0 |
| Help Seeking | Academically successful students | 0 | 0 | 20% | 20% | 60% | % | 0 |
| | Academically average students | 0 | 0 | 0 | 36% | 50% | 14% | 0 |
| | Academically unsuccessful students | 0 | 0 | 17% | 17% | 50% | 16% | 0 |

**Table C7**

Correlations between motivation scales and academic results for level 1students

| Motivation Scales | Correlation co-efficient (r) |
|---|---|
| Intrinsic Motivation | -0.03 |
| Career Motivation | -0.19 |
| Self Determination | -0.01 |
| Self-efficacy | 0.10 |
| Grade Motivation | 0.04 |

**Table C8**

Correlations between motivation constructs and academic results for level 2 students

| Motivation Scales | Correlation co-efficient (r) |
|---|---|
| Intrinsic Motivation | -0.27 |
| Career Motivation | -0.22 |
| Self Determination | -0.12 |
| Self-efficacy | -0.12 |
| Grade Motivation | -0.12 |

**Table C9**

Correlations between motivation constructs and academic results for level 3 students

| Motivation Scales | Correlation co-efficient (r) |
|---|---|
| Intrinsic Motivation | -0.27 |
| Career Motivation | -0.22 |
| Self Determination | -0.12 |
| Self-efficacy | -0.12 |
| Grade Motivation | -0.12 |

**Table C10**

Correlations between learning strategy scales and academic results for level 1students

| Motivation Scales | Correlation co-efficient (r) |
|---|---|
| Rehearsal | 0.17 |
| Elaboration | 0.13 |
| Organisation | 0.12 |
| Critical thinking | -0.25 |
| Metacognitive Self-regulation | -0.20 |
| Time and Study Environment | 0.00 |
| Effort regulation | 0.10 |
| Peer Learning | -0.26 |
| Help Seeking | -0.25 |

**Table C11**

Correlations between learning strategy scales and academic results for level 2 students

| Motivation Scales | Correlation co-efficient (r) |
|---|---|
| Rehearsal | 0.02 |
| Elaboration | -0.03 |
| Organisation | 0.33 |
| Critical thinking | 0.09 |
| Metacognitive Self-regulation | 0.25 |
| Time and Study Environment | 0.09 |
| Effort regulation | -0.13 |
| Peer Learning | 0.03 |
| Help Seeking | 0.07 |

**Table C12**

Correlations between learning strategy scales and academic results for level 3 students

| Motivation Scales | Correlation co-efficient (r) |
|---|---|
| Rehearsal | 0.32 |
| Elaboration | 0.24 |
| Organisation | 0.13 |
| Critical thinking | 0.22 |
| Metacognitive Self-regulation | 0.37 |
| Time and Study Environment | 0.01 |
| Effort regulation | 0.01 |
| Peer Learning | 0.18 |
| Help Seeking | 0.00 |

# APPENDIX D INFORMED CONSENT LETTERS

## DECLARATION OF CONSENT

## PROJECT TITLE:


**RESEARCHER**

Full Name: Nkosinothando Chamane

School: School of Education

College: University of KwaZulu-Natal

Campus: Edgewood

Proposed Qualification: Masters in Science education

Contact: 0760133775

Email: thandocharmane@yahoo.com

**SUPERVISOR**

Full Name of Supervisor: Miriam Lebala Kolobe

School: School of Education

College: University of KwaZulu Natal

Campus: Edgewood

Contact details: 031 260 3785

Email: kolobe@ukzn.ac.za

**HSSREC RESEARCH OFFICE**

Full Name: PremMohun
HSS Research Office
GovanBheki Building
Westville Campus
Contact: 0312604557
Email: mohunp@ukzn.ac.za


I, NkosinothandoChamane, Student no. 207511706 am a Masters student, at the School of Education, at the University of Kwazulu Natal. You are invited to participate in a research project entitled: Investigating the pre-service teachers' motivation, learning strategies and their impact on performance: An explanatory study of Physical Sciences student teachers at a tertiary institution in South Africa. This study aims to contribute in assisting the Universities to produce science teachers who are motivated to teach science, with self-regulated learning skills and good teaching practices.

I would like your consent to participate in my research project. I am interested in your motivation and the learning strategies you use to study Physical Science education. You will be asked to complete two questionnaires relating to your motivation to science and your learning strategies. Some of you will be interviewed.

The identities of all the participants will be protected in accordance with the code of conduct as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of all participants and you have the right to withdraw from the study should you feel the need to do so and this will have no consequences on you and your studies. Your names and/or the name of the University will not appear in my report or in any presentations that I make after this study.

**DECLARARTION FOR CONSENT**

I……(Full Name) hereby confirm that I have read and understood the contents of this letter and the nature of the research project has been clearly defined prior to participating in this research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

Participants Signature……

Date……..

**LETTER TO THE DEAN**

13 Ross Street

Amanzimtoti

4126

04 May 2015

Dear Professor Kamwendo

REQUEST FOR PERMISSION TO UNDERTAKE A PHYSICAL SCIENCE EDUCATION RESEARCH STUDY IN THE SCHOOL OF EDUCATION, SCIENCE DISCIPLINE

My name is Nkosinothando Chamane and I am a Masters of Education student registered at the University of KwaZulu-Natal (Edgewood Campus).

I am presently engaged in a research study towards the said Degree on student's motivation to study Physical Sciences (physics and chemistry) education specialisation, the learning strategies they use to do so and the impact of these on their performance. This study aims to contribute in assisting the Universities to produce science teachers who are motivated to teach science, self-regulate their learning and demonstrate good teaching practices.

I request your consent for pre-service teachers specialising in Physical Science education years I, II and III to participate in my research project. The students will be asked to complete two questionnaires relating to their motivation to learn science and their learning strategies. Some of them will be interviewed based on their responses to these questionnaires and overall performance in the respective modules.

The identities of all the participants will be protected in accordance with the code of conduct as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of all participants and each student will be free to withdraw from the research at any time without any undesirable consequence to them. The students' names and/or the name of the University will not appear in my report or in any presentations that I make after this study.

My Supervisor is Ms Lebala Kolobe, she can be contacted for further inquiries on 031 260 3785 / kolobe@ukzn.ac.za at the School of Education, Edgewood Campus.

Yours Faithfully

Miss N. Chamane.

Kindly indicate your willingness to give permission for the relevant students and lecturers in the School of Education to participate in my research project. I thank you for taking the time to read this letter.

I hereby confirm that I understand the contents of this document and the nature of the research project, and I consent for relevant students and lecturers in the School of Education participating in the research project.

| | |
|---|---|
| Signature | Date |

**LETTER TO THE CLUSTER LEADER**

13 Ross Street

Amanzimtoti

4126

_May 2015

Dear Dr Govendor

REQUEST FOR PERMISSION TO HAVE THE STUDENTS IN YOUR CLUSTER OF SCIENCE AND TECHNOLOGY TO PARTICIPATE IN A PHYSICAL SCIENCE EDUCATION RESEARCH STUDY

My name is Nkosinothando Chamane and I am a M. Ed student registered at the University of KwaZulu-Natal (Edgewood Campus).

I am presently engaged in a research study on student's motivation to study Physical Science education, the learning strategies they use to do so and their impact on performance in fulfilment of the said Degree.

I would like your consent for your pre-service teachers specialising in Physical Science education to participate in my research project. The students will be asked to complete two questionnaires, one relating to their motivation to learning science and the other on their learning strategies. Some of them will be interviewed based on their responses to questionnaires and overall performance in the respective modules. The whole process of data collection (questionnaires and interviews) is expected to take three 45 minute sessions. Interviews will be done outside lecture times.

The identities of all the participants will be protected in accordance with the code of conduct as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of all participants and each student will be free to withdraw from the research at any time without any undesirable consequence to them. The student names and/or the name of the University will not appear in my report or in any presentations that I make after this study.

My Supervisor is Ms Lebala Kolobe, she can be contacted for further inquiries on 031 2603785 / kolobe@ukzn.ac.za at the School of Education, Edgewood Campus.

Yours Faithfully

Miss N. Chamane.

Kindly indicate your willingness to give permission for concerned students and lecturers in your cluster to participate in my research project. I thank you for taking the time to read this letter.

I hereby confirm that I understand the contents of this document and the nature of the research project, and I consent for concerned students and lecturers participating in the research project.

| | |
|---|---|
| Signature | Date |

**LETTER TO THE LECTURER**

13 Ross Street

Amanzimtoti

4126

_May 2015

Dear Sir/Madam

REQUEST FOR PERMISSION TO HAVE THE STUDENTS IN YOUR CLASS AND YOURSELF TO PARTICIPATE IN A PHYSICAL SCIENCE EDUCATION RESEARCH STUDY

My name is Nkosinothando Chamane and I am a M. Ed student registered at the University of KwaZulu-Natal (Edgewood Campus).

I am presently engaged in a research study on students' motivation to study Physical Science education, the learning strategies they use to do so and their impact on performance in fulfilment of the above mentioned Degree.

I would like your consent for your pre-service teachers specialising in Physical Science education and yourself to participate in my research project. The students will be asked to complete two questionnaires relating to their motivation to learning science and their learning strategies. Some of them will be interviewed based on their responses to questionnaires and overall performance in the respective modules. The whole process of data collection (questionnaires and interviews) is expected to take three 45 minute sessions. Interviews will be done outside lecture times.

The identities of all the participants will be protected in accordance with the code of conduct as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of all participants and each student will be free to withdraw from the research at any time without any undesirable consequence to them. The student names and/or the name of the University will not appear in my report or in any presentations that I make after this study.

My Supervisor is Ms Lebala Kolobe, she can be contacted for further inquiries on 031 260 3785 / kolobe@ukzn.ac.za at the School of Education, Edgewood Campus.

Yours Faithfully

Miss N. Chamane.

Kindly indicate your willingness to give permission for students in your class and yourself to participate in my research project. I thank you for taking the time to read this letter.

I hereby confirm that I understand the contents of this document and the nature of the research project, and I consent for my students participating in the research project.

| | |
|---|---|
| Signature | Date |

**LETTER TO THE PARTICIPANT**

13 Ross Street

Amanzimtoti

4126

_ May 2015

Dear Student

SELECTION AND PARTICIPATION IN A PHYSICAL SCIENCE EDUCATION RESEARCH PROJECT

My name is Nkosinothando Chamane and I am a M. Ed student registered at the University of KwaZulu Natal (Edgewood Campus).

I am presently engaged in a research study on student's motivation to study Physical Science education, the learning strategies they use to do so and their impact on performance. I wish to inform you that your class has been selected as one of the groups of students I would like to participate in my research study. This study aims to contribute in assisting the Universities to produce science teachers who are motivated to teach science, with self-regulated learning skills and good teaching practices.

I would like your consent to participate in my research project. I am interested in your motivation and the learning strategies you use to study Physical Science education. You will be asked to complete two questionnaires relating to your motivation to science and your learning strategies. Some of you will be interviewed.

The identities of all the participants will be protected in accordance with the code of conduct as stipulated by the University of KwaZulu-Natal. I undertake to uphold the autonomy of all participants and you have the right to withdraw from the study should you feel the need to do so and this will have no consequences on you and your studies. Your names and/or the name of the University will not appear in my report or in any presentations that I make after this study.

My Supervisor is Ms Lebala Kolobe, she can be contacted on 031260 3785 / kolobe@ukzn.ac.za at the School of Education, Edgewood Campus.

Yours Faithfully

Miss N. Chamane.

Kindly indicate your willingness to participate in my research project. I thank you for taking the time to read this letter.

(Please complete the declaration below, and return to me).

I hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

| | |
|---|---|
| Student Signature | Date |

# APPENDIX E ETHICAL CLEARANCE CERTIFICATE

Attached separately as pdf

# APPENDIX F EDITOR'S CONFIRMATION LETTER

**Macheli M Property Consulting and General Trading**

P.O. Box 291205

Melville 2109

Cell: 0723618617

Fax/email:makhomo@live.com

10 June 2016

TO WHOME IT MAY CONCERN

Confirmation Letter

I Ms Makhomo Macheli confirm that I assisted in the review and edit of thesis entitled "Investigating the pre-service teachers' motivation, learning strategies and their impact on performance: An explanatory study of Physical Science student teachers at a tertiary institution in South Africa" by Nkosinothando Chamane. The review and edit specifically focused on language, format, coherence and references. Suggestions for the changes to be made were communicated with the student, however these had no influence on the content or structure of the above mentioned thesis.

Sincerely

Ms M Macheli